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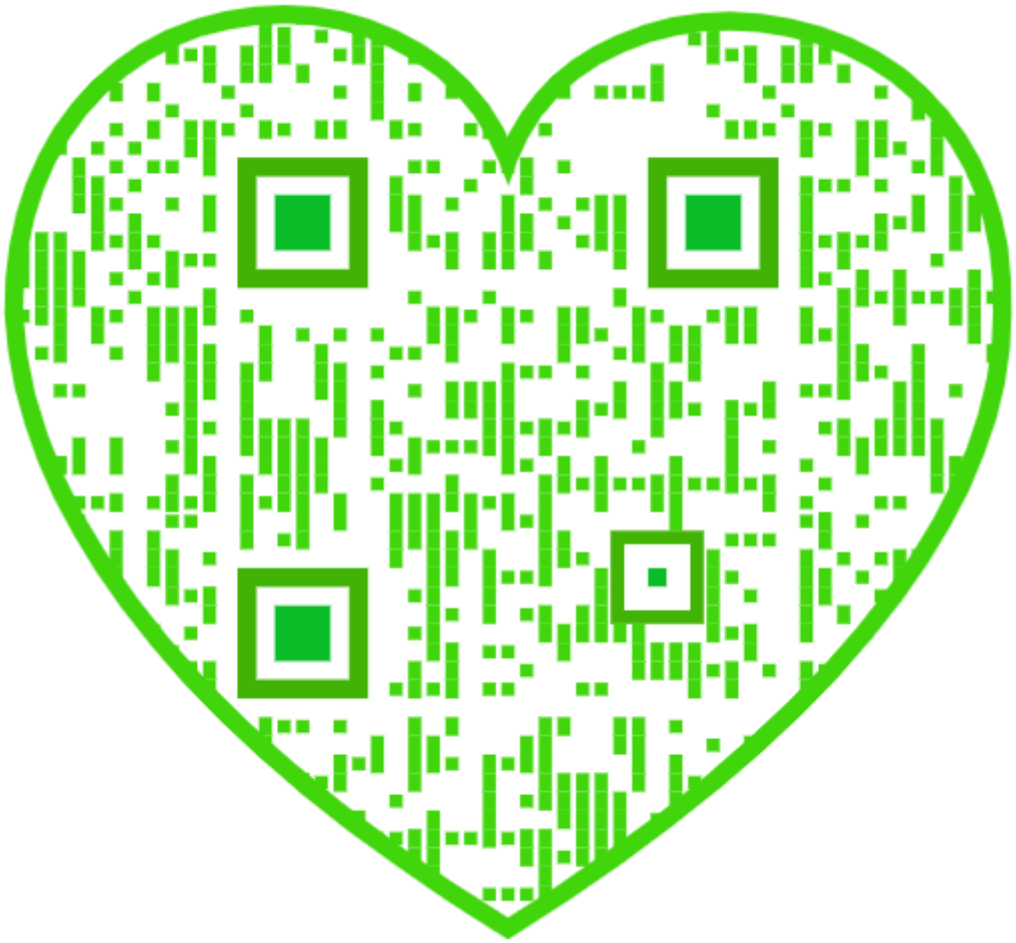

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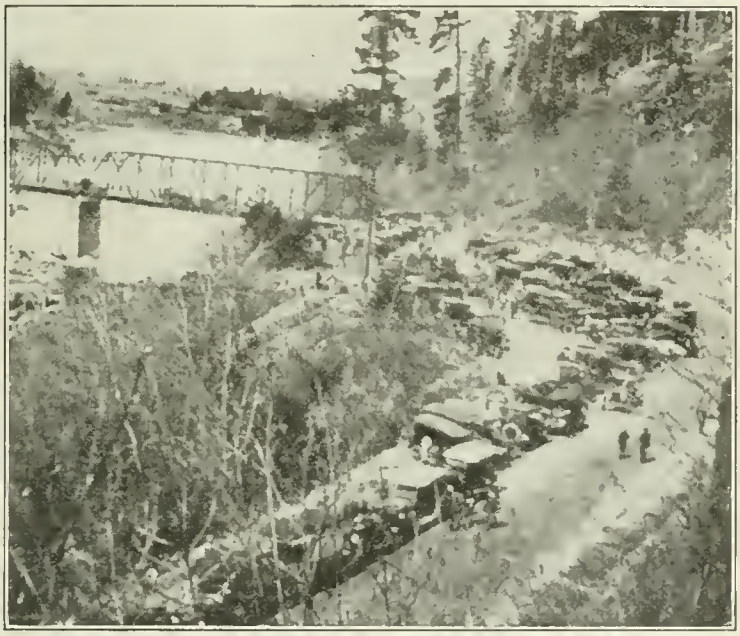

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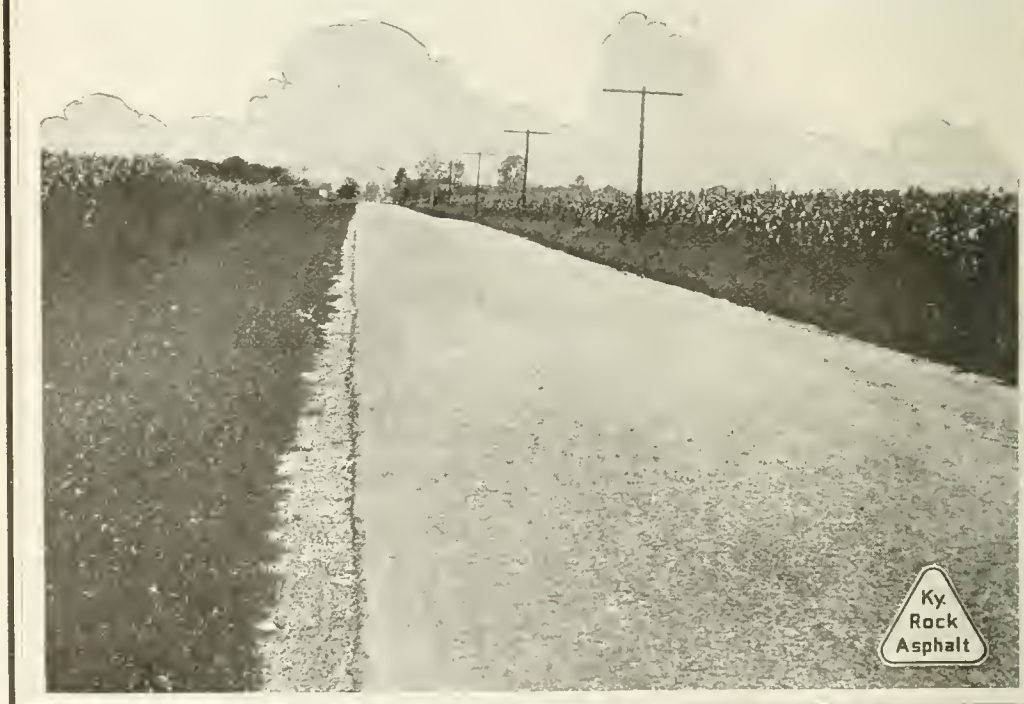

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3½"	x	4 "	x	8½"

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Width		Depth		Length
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4 "	x	3½"	x	8½"

WIRE-CUT LUG BRICK (DUNN)

Width		Depth		Length
3½"	x	3 "	x	8½"
3½"	x	3½"	x	8½"
3½"	x	4 "	x	8½"

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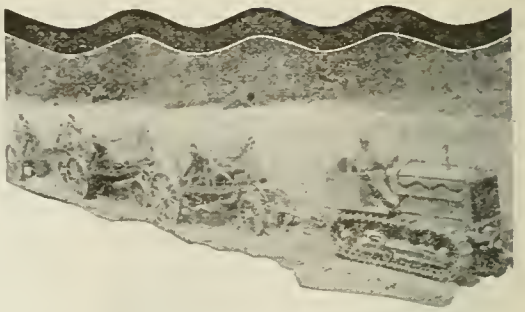

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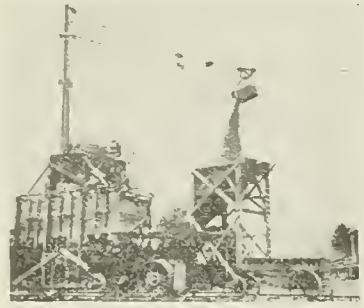

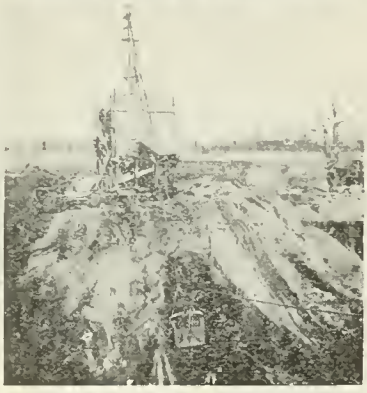

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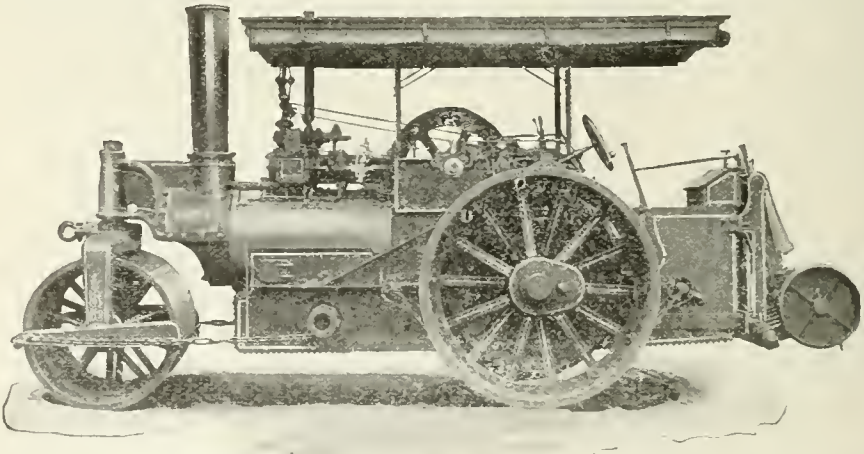

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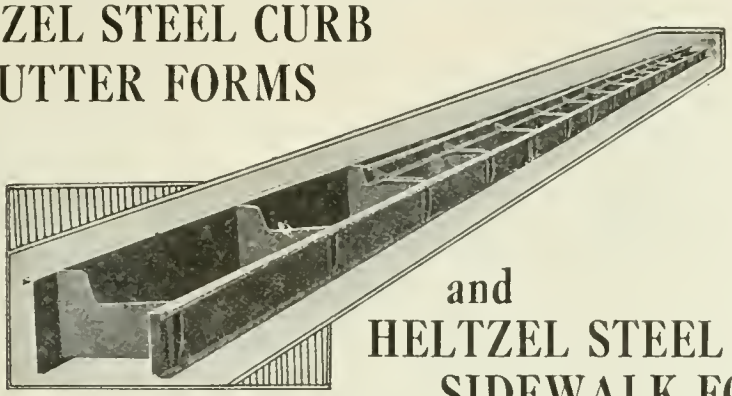

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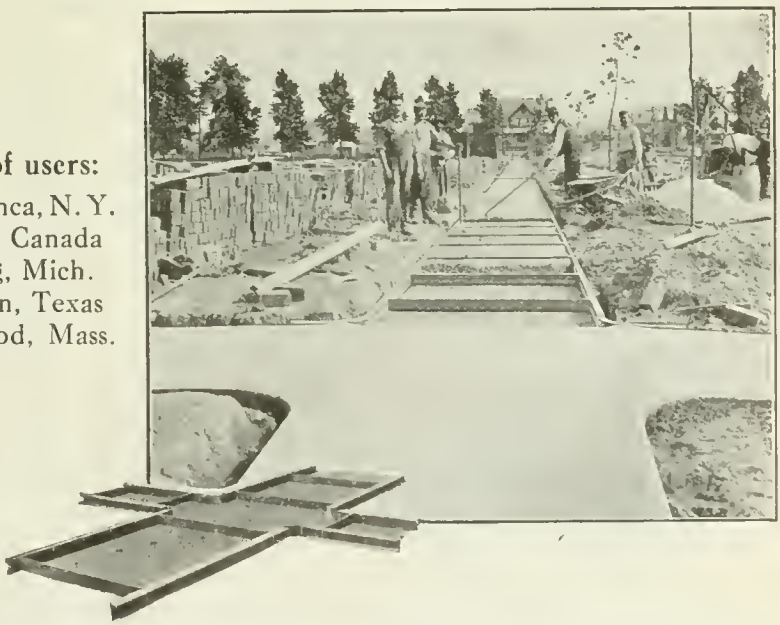

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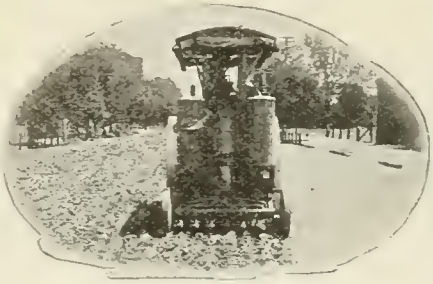

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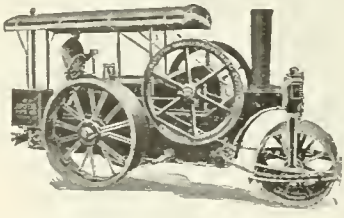

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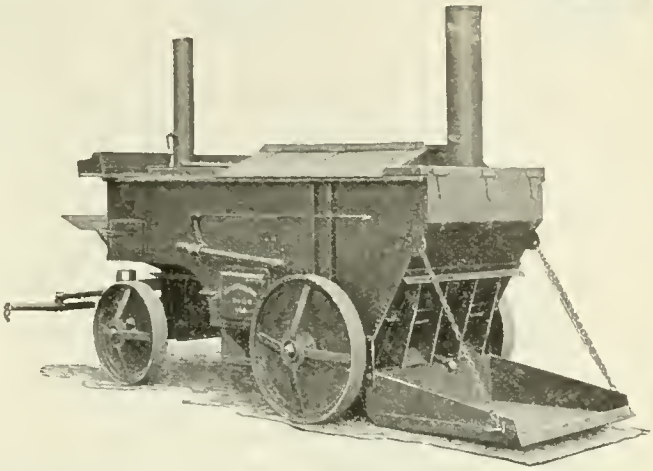

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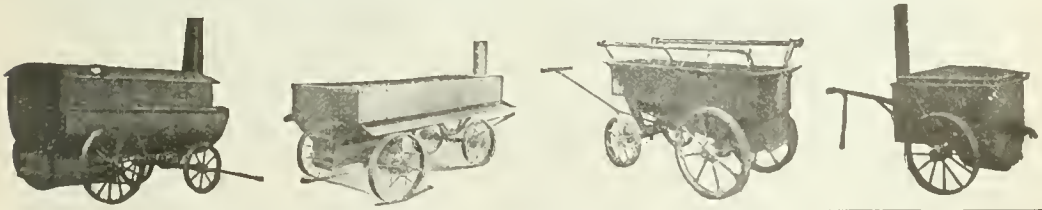

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Capacity 750, 1250 and 1800 Square Yards 2-inch Top or Macadam Daily

THE CUMMER ONE-CAR ASPHALT PLANT

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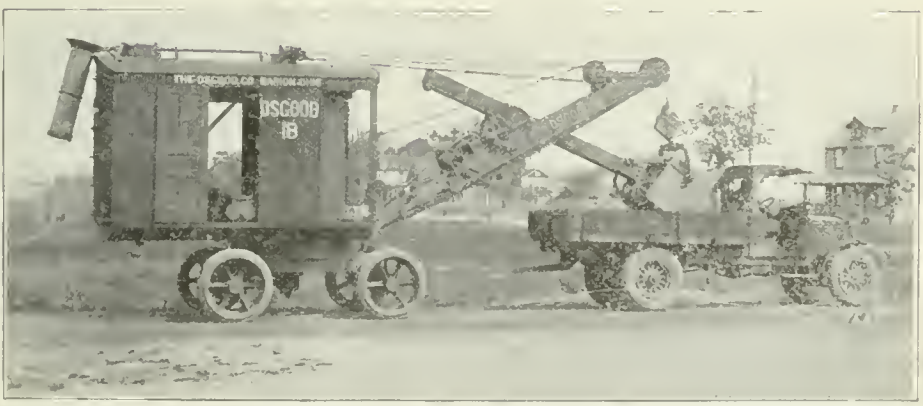
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



MOTOR TRUCK TOWING OSGOOD STEAM SHOVEL. NOTE RUBBER TIRES ON THE SHOVEL TO PREVENT DAMAGE TO PAVEMENTS.

Motor Truck Operation and Accounting—77

HOW MODERN, MOTORIZED EQUIPMENT SPEEDED UP WORK ON JOHNSON CREEK, WISCONSIN ROAD JOB

Last season Peppard, Burrill & Connell, prominent Minneapolis contractors, built a section of concrete road 4.7 miles in length connecting Watertown and Johnson's Creek, Wisconsin.

After making a careful survey of the hauling situation they decided to use Kissel equipment. They selected the following equipment—a Kissel patented combination hopper and measuring box with a bin capacity of 20 yds. of stone and 10 yds. of sand, 9 special Kissel Road Builder trucks of 3-yd. capacity each, and a special designed turntable for turning loaded trucks.

In selecting equipment of this nature, Peppard, Burill & Connell figured that they would reduce their costs to a minimum, because they would eliminate one of the usual items of expense, namely delays.

It is interesting to see how the Kissel Road-builders carried out and systematized this work—from devising a hopper that saved hundreds of hours of time to delivering the batches in record time and turning and dumping into the mixer at a decreased cost in time, labor and money.

Work commenced on the road July 6th with favorable weather conditions. Sand and gravel were shipped in, the cars were unloaded by a crane and clam shell, and the material was put in two large stock piles where it could be quickly loaded into the bins of the hopper.

In order to appreciate the advantages of handling material in this manner from the standpoint of saving in time and labor alone, the following statistics regarding the time it takes to load hoppers, measuring boxes and trucks will prove interesting. The time required to unload one clam shell-into bin is 35 seconds. Time required to charge the 9 measuring boxes is 12 seconds. Time required to empty 9 measuring boxes, 2 seconds.

There is no question but that the motor truck is the most efficient way to transport material, providing it is properly designed and equipped. It is necessary to go further than this, however, to make motor transportation practical. First, a contractor should have a standardized equipment, and second, proper supervision must be furnished. Unquestionably one of the greatest advantages which systematic supervision of motor equipment affords besides protection for the trucks, is the opportunity to keep every unit of the transportation scheme in constant, profitable motion. The ability of gasoline trucks to run without rest gives them a superiority over both horsepower and electric vehicles. The mechanic whose duty it is to see that the truck equipment receives proper care, should be carefully selected. They hold an important place in the contractor's organization. Remember the average road trucks receive more usage in 24 hours than trucks hauling for commercial purposes do in a much greater length of time, and therefore should receive the best of care when the day's work is done.

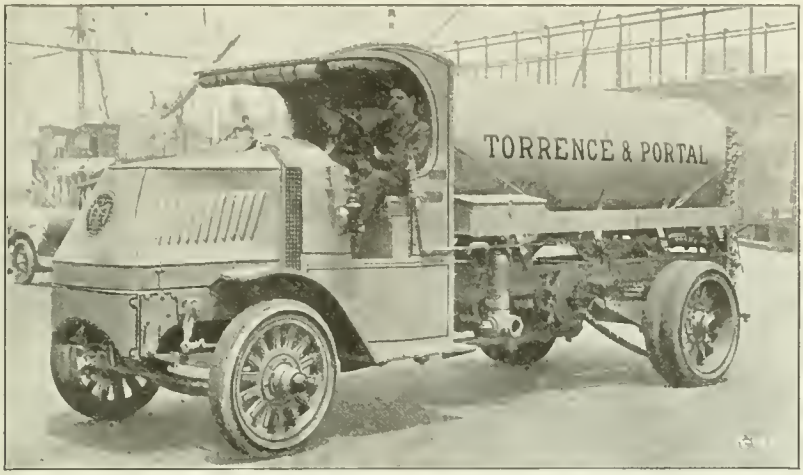
The driver has done his share when he drives eight or ten hours a day. He should not be relied upon to grease and oil the trucks. It is much better and more profitable in the long run to have an A-1 mechanic held responsible for greasing, oiling and overhauling the trucks.

The above method was used on the Johnson Creek job, with the result that it was one of the many items that helped to eliminate delays—the equipment was in tip-top shape every morning when it went out on the job.

The special Kissel road builders' truck is specially designed and adapted to meet all road-building requirements. In designing it, special attention was paid to the three leading truck factors essential for contracting and road-building work—power, durability and economy.

Kissel designed and built the proper powered motor for this job—a power plant fully capable to meet every power demand. It powers at 25 miles per hour loaded—and 30 miles per hour empty. It raises a 3-batch load in 10 seconds—unloading 3 batches in 7 seconds. It is particularly adaptable for grades and soft dirt roads. The power capacity is unlimited as contractors and owners assert.

A special double frame is used to insure flexibility and strength. Extra heavy springs not only insure proper



The Mack Light Bituminous
Material Distributor

Your road maintenance next Spring

Now is the time to get ready

INCLUDED in our unusual line of special motorized equipment for municipalities, counties and contractors is this Mack Light Bituminous Material Distributor.

This equipment is a fool-proof machine for handling cold material and requires only a driver for its operation. The elimination of the extra operator which is usually needed on ordinary machines, means economy for its owner.

The tank body can be demounted when its particular work is done and a dump body substituted. This continuous chassis use effects large savings and many highway boards and commissioners are finding this a practical way to economize on their road maintenance equipment.

Mack TRUCKS

Capacities:
1½ to 7½ tons.
Tractors to 15 tons.

INTERNATIONAL MOTOR COMPANY
25 Broadway, New York

PERFORMANCE COUNTS

In writing to advertisers please mention MUNICIPAL AND COUNTY ENGINEERING

resiliency for full load on uneven roads, but give added life to the entire body structure. Heavy duty front and worm-drive rear axles are regular Kissel equipment. A special short wheelbase is provided—with 36x6-in. front and 42x9-in. rear pneumatic cord tires.

A special 3-yd. capacity body of 8-gauge steel is mounted on a horizontal 2-cylinder hoist, operated from the driver's seat. Body is 9 ft. long, 6 ft. wide and 24 ins. deep, with single acting tail gate equipped with manual control and chain spreading device. Two swinging partitions divide body into three 1 cu. yd. compartments. Special sectional driver's cab and power tire pump are additional standard equipment.

The specially Kissel designed turntable was found to be a great time-saver on this job—the loaded truck comes down the grade to a point about 250 ft. in advance of the mixer. Here it runs onto the turntable and in 10 seconds it is turned completely around, ready for backing up to the mixer skip. This again saved time for the contractor as it has been tried and found to be impossible to turn a truck around on the grade as quickly and without cutting up the grade. Again, a few seconds were saved on each truck every trip, which is a material saving of time in a day's run.

The secret of success in truck hauling is to keep a truck loaded with material at the paver all the time, and by being able to do this Peppard, Burill & Connell were able to complete their 4.7 miles of paving in the record time of 40 actual working days.

For the benefit of the reader, we give herewith various data and statistics of progress from start to finish on the Johnson Creek, Wis., road job:

JOHNSON CREEK ROAD COMPUTATIONS

The Entire Job.

Average Daily Footage 620.4 feet.

Length of road 4.7 miles or 24,816 feet. Total number of days on which any work whatsoever was done—40.

ONE WEEK'S WORK

Daily Average Footage 766 Feet.

In completing this job of 4.7 miles of concrete road, there was only one week in which the work was not delayed by rains and wet roads—the week of August 21st to 27th. The footage this week by days was:

Monday	681 ft.
Tuesday	711 ft.
Wednesday	903 ft.
Thursday	794 ft.
Friday	700 ft.
Saturday	866 ft.

Total footage for the week 4655 ft.

Number of days worked—6.

PROGRESS FROM AUG. 1 TO END OF JOB

Average Daily Footage of 736 ft.

During the period from August 1st to September 6th, when the job was completed, rain and wet roads prevented any work on 8 working days. On two days, namely, August 16th and 18th, only a half day's work was possible, due to rain. Despite this handicap, the total footage for this period was 15,447 ft. The number of days worked—21.

TIME CONSUMED IN OPERATING KISSEL TRUCKS AND EQUIPMENT.

Johnson Creek, Wis. Road Contract.

Loading, raising and emptying $1\frac{1}{4}$ cu. yd. clam into bin	35 seconds
Charging nine measuring boxes (6 boxes of 18 cu. ft. gravel; 3 boxes 10 cu. ft. sand)	12 seconds
Locking truck partitions—backing under hoppers—receiving load and starting on trip averages	25 seconds
Discharging 9 measuring boxes into truck	2 seconds
Speed of Kissel truck—loaded with 3 batches	25 M. P. H.
Speed of Kissel truck unloaded	30 M. P. H.
Turning loaded truck on turntable	10 seconds
Backing to mixer—dumping 3 batches into skip end and starting on return trip	4 minutes

JOHNSON CREEK FOOTAGE TABLE.

Work started ..... July 6, 1921

Finished ..... September 6, 1921

FOOTAGE TABLE.

Daily Average Footage—736 feet.

Highest Daily Footage—903 feet, August 24th.

(Showing daily progress after August 1st.)

Aug. 1—Rain	Aug. 14—Sunday	Aug. 28—Sunday
2—Rain	15—827 ft.	29—855 ft.
3—570 ft.	16—498 ft	30—318 ft.
4—742 ft.	(Rain 6 hr. wk.)	(Rain 4 hr. wk.)
5—711 ft.	17—Rain	31—Rain
6—723 ft	18—352 ft.	
	(Rain 4 hr. wk.)	
	19—615 ft.	
	20—Rain	Sept. 1—Wet Rd.
7—Sunday	21—Sunday	2—520 ft.
8—845 ft.	22—681 ft.	3—645 ft.
9—813 ft.	23—711 ft.	4—Sunday
10—Rain	24—903 ft.	5—Labor Day
11—Wet	25—794 ft.	6—520 ft.
Road	26—700 ft.	(End 6 hr. wk.)
12—620 ft.	27—866 ft.	
13—618 ft.		

Total footage after Aug. 1 ..... 15,447 Total working days after Aug. 1 21

(Note—Aug. 16th and 18th counted as one day, also Aug. 30th and Sept. 6th, as delay on these days due to rain.)

PERFORMANCE OF MACK TRUCKS ON ROAD AND STREET WORK

That the public in general appreciates the necessity of more and better highways is indicated by the fact that approximately a billion dollars are now available for building them in the United States. President Harding has emphatically declared his approval of a policy giving generous support to road-building and miantenance.

It remains only for the highway contractors to speed up operations, employing the best materials and methods, and the most modern equipment. A few typical instances of how this is being done, that have recently been called to our attention, are briefly outlined herewith.

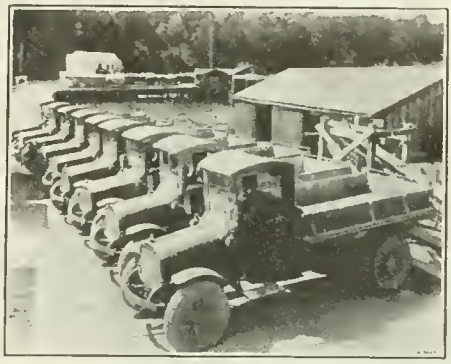
The fleet of nine 2½-ton Macks shown in the illustration, is operated by the Kaiser Paving Company, a large road construction concern in the Pacific Northwest, with headquarters at Seattle, Wash. These trucks have recently completed what was originally considered to be an impossible road-building contract of six miles in length on Vashon Island, in Puget Sound. Many difficulties surrounded this contract, including a steady 8 per cent grade for 1⅛ miles from the bunker, and the fact that the frequent and excessive rains in this section at times made the road almost impassable. The nine Macks were the only trucks used on this work.

Johnson, Drake & Piper, highway contractors of Minneapolis, recently created considerable interest among other contractors in that section by demonstrating without question the practicability and economy of using trucks for paving work. On a 15-mile paving project in Southern Minnesota the "dry batch" method was used, employing a centrally located proportioning hopper from which correctly measured batches of sand, crushed rock and cement were delivered simultaneously into the different compartments of the truck body. The truck equipment consisted of ten 2½-ton Macks with dump bodies divided crosswise in the center by a swinging partition.

After receiving the sand, crushed rock and cement, the truck proceeded to the multipedal mixer located on the road at a point where the paving was being laid, and discharged the rear batch first into the skip of the mixer. By elevating the skip, this batch was dumped directly into the drum of the mixer, and the skip was then lowered again to receive the second batch from the truck. The body of the truck was kept in an elevated position during the time the skip was delivering the first batch into the mixer, and the second batch was discharged simply by operating the trip lever on the outside of the body.

Each batch measured 30 cu. ft., and each truck carried two batches. Records of from 2½ to 3 miles of road construction per month were made.

In municipal work also the motor truck has not only met the demand for speed-



FLEET OF NINE 2½-TON MACK TRUCKS AS OPERATED BY THE KAISER PAVING CO., SEATTLE, WASH.

ing up road work, but has complied with the requirements of modern machinery. This result has been brought about by furnishing the means of quickly carrying material from one point to another, for pulling light road-scrapers and road drags, and for rapidly covering long stretches of highway where a small amount of work is to be performed at widely separated points.

The results obtained by the use of the motor truck in several townships in New York State indicate that the motor truck on short hauls displaces four to five 2-horse teams, and on hauls over two miles displaces six to eight teams with a saving of from $6 to $15 per day in the performance of the same amount of work. In one instance, a 2-ton Mack, when attached to a light road-scraper, has proved to be the equivalent of two teams of horses in pulling power and does twice the amount of work.

MOTOR TRUCK NEWS NOTES

Modern Trucks Speed Up Highway Construction

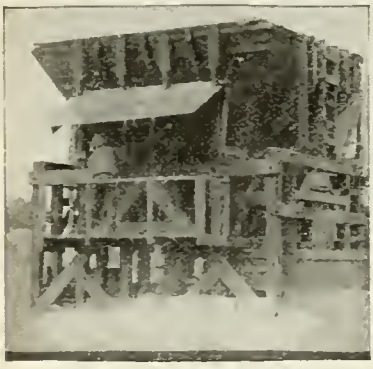
Speed records in road construction work have been shattered during the last few

KISSEL

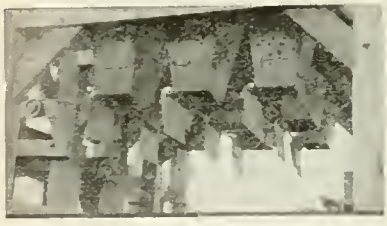
Actual working models of patented Hoppers, Measuring Boxes, Turntables and Trucks at the

Chicago Good Roads Show, Coliseum, January 16-20, 1922.

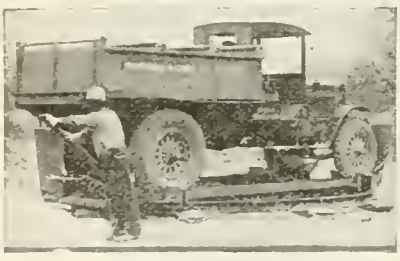
Loading the bins in the Kissel patented Hopper with clam.



One man easily operates levers that control the dumping of measuring boxes into truck.



Interior of Kissel patented hopper showing loading funnels of measuring boxes built into top of hopper.



Kissel Special Road-builder's truck on specially designed turntable,

Loads Correct Amount of Sand, Gravel or Cement into Trucks in Two Seconds

THE Kissel patented combination hopper and measuring boxes (patent applied for) have revolutionized handling and loading materials—eliminating waste, saving time and labor.

The Kissel hopper has a storage bin capacity of 20 yards of stone and 10 yards of sand. Equipped with 9 measuring boxes—3 boxes with a capacity of 10 cu. ft. of sand, and 6 boxes of 9 cu. ft. of stone. Measuring boxes equipped with a patented adjustable arrangement so that capacity can be varied quickly and easily.

One clam shell loads bin in 35 seconds—measuring boxes loaded in 12 seconds. Three batches dumped into truck in 2 seconds.

Where trucks haul a dry mix, trucks stop only 2 seconds under Kissel cement hopper to receive properly measured portion of cement.

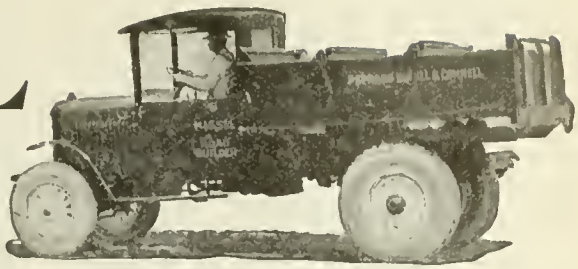
Loaded Truck Completely Turned Around on this Turntable in Ten Seconds.

Simple and durable in construction—unusually efficient to operate—saves wear on truck and final grade—mounted on skids for easy moving by truck—strongly built—rollers equipped with bearings.

This important time and labor-saving device is placed about 500 feet in front of the mixer—the loaded truck drives right upon it, where it is turned around in less than 10 seconds, preparatory to backing up to the mixer.

KISSEL MOTOR CAR CO.
HARTFORD, WIS., U.S.A.

KISSEL



Special Road-builder's Truck will be Exhibited at Chicago Good Roads Show, Coliseum, January 16-20, 1922

Specially Designed and Built—Geared and Powered to carry a 3 cubic yard load from Hopper to Mixer on an uninterrupted schedule.

CONTRACTORS' and roadbuilders' requirements demand the dependability, economy and durability of Kissel's special Road-builder's truck—avoiding the slow-ups that delay daily footage.

Throughout 1920 and 1921, these trucks in the hands of owners proved not only unusually economical, but thoroughly dependable, easy to handle, with plenty of power and ability to carry full loads.

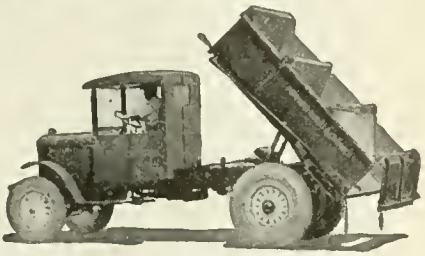
In the Kissel special Road-builder's truck the Kissel engineering department paid special attention to the three leading truck factors for contracting and road-building work—

POWER — DURABILITY — ECONOMY

Power—Kissel designed and built the proper powered motor for this job—fully capable to meet every power demand. Speed 25 miles per hour empty and 20 miles per hour loaded. It raises a 3-batch load in 10 seconds, unloading 3 batches in 7 seconds.

Durability—A special double frame insures flexibility and strength. Extra heavy springs give proper resiliency for full load on uneven roads and added life to the entire body structure. Heavy duty front and worm-drive rear axles are regular Kissel equipment. A special short wheelbase is provided.

Economy—Due to careful engineering, quality materials, oversize units and sturdy construction, the Kissel special Road-builder's truck is not only unusually economical, but practically free from repair work.



Kissel special Road-builder's Truck with body divided for three batches of one cubic yard each.

Special double frame and extra strong springs on Kissel special Road-builder's truck.

Body Equipment—A special 3-yard capacity body is mounted on a horizontal hoist, operated from driver's seat. Body is 9 ft. long, 6 ft. wide, and 24 ins. deep. Special sectional driver's cab and power tire pump are additional standard equipment.

Kissel Road Division will Furnish Trucks with Drivers, Hoppers, Measuring Boxes and Turntables to handle your haulage work.

Occasionally a contractor is not in the market for equipment, but prefers to sub-let his hauling. Kissel road engineering service has a plan whereby a bid will be made on your hauling—provide a fleet of Kissel special Road-builder's trucks, each one driven by its owner—a Kissel patented hopper with measuring boxes and turntable—operated under proper supervision and furnished with the best service facilities—taking over your hauling problems and systematically keeping up an uninterrupted flow of material to your mixer.

Special Kissel Exhibit at Chicago Good Roads Show

The special Kissel Exhibit at the Coliseum Good Roads Show, January 16th to 20th, will consist of complete working models of the Kissel Patented Combination Hopper and Measuring Boxes, Turntable, and Special Road-builder's Truck. Don't miss it.

KISSEL MOTOR CAR CO., Hartford, Wis., U.S.A.

months as a result of a more rapid handling of raw materials, according to contractors.

The increasing use of motor trucks during the last few years aided greatly in accelerating the building of roads, but recent improvements in motor truck design have enabled operators to haul more materials than ever before.

As an instance of this may be cited the Montclair-Danville road near Newark, N. J., completed recently. The contractors laid this 20-ft. concrete highway at a rate of more than 700 ft. a day. The materials had to be hauled an average of four miles, but motor trucks maintained a steady flow of crushed stone and other materials.

Among the trucks on this job were four Pierce-Arrow units of the Dual Valve type, equipped with dump bodies. These trucks develop greater pulling power and hill-climbing ability than any truck yet designed, and as a result they easily outstripped the other trucks in making the run between the stone hoppers and the concrete mixers four miles distant. The route led them over the Hook Mountain hill, which they ascended, fully loaded, in high gear, while the others crawled slowly up in second or third.

This test which involved continual deep ruts, mud and chuck holes, demonstrated the ability of the Dual Valve trucks so forcefully that the truck operator, Mr. Eugene Wendling, of Newark, purchased six additional Pierce-Arrow units.

New General Motors Truck Prices

The General Motors Truck Company, of Pontiac, Mich., announced this week a substantial reduction on its line of heavy duty trucks to become effective Jan. 1.

These new prices represent a reduction from the original price of these models ranging from $625 to $1,050 per chassis, and are as follows:

2-ton (Model K-41).....$2,775
3½-ton (Model K-71).....$3,950
5-ton (Model K-101).....$4,350

The one-ton chassis of this series was recently reduced to $1,495. In announcing these reductions, Mr. W. L. Day, President and General Manager of the General Motors Company, stated:

"These new prices are in keeping with the spirit of the times. There is greater need today for economical, efficient motor transportation than perhaps ever before. In fact, it is vitally essential to the future stability of business. The more extensive use of high grade dependable motor trucks at this time will assist materially in reducing delivery costs which are big items in overhead expense in all lines of commercial and industrial activity.

"This saving that motor trucks effect will permit in turn the lowering of prices on the finished products, and thus create a healthy trade stimulus which will hasten the period of normalcy and general business prosperity to which we are all looking forward.

Handling War Truck Bodies

When the Indiana State Highway Commission was recently allotted 15 ex-military F. W. D. trucks by the Government for highway construction and maintenance purposes, they immediately started overhauling and equipping them for service.

When the trucks were nearly ready for the road, the question of proper body equipment came up for solution. To purchase new bodies would have meant the expenditure of quite a large sum of money and the scrapping of the ammunition bodies, which came with the trucks. That is not what was done, however—they cut the ammunition bodies down and at almost no expense made them into 2½-yd. dump bodies, which will answer the purpose as well as any $250 or $300 body.

KISSEL DISPLAYS COMPLETE ROAD BUILDING EQUIPMENT AT CHICAGO GOOD ROADS SHOW

An exhibit of road building equipment and engineering that will attract unusual attention at the Chicago Good Roads Show at the Coliseum January 7th to 20th, will be that of the Kissel Motor Car Company. In addition to a completely equipped Special Kissel Road Builder's Truck, quarter size working models of the Kissel patented hopper and measuring boxes and special designed turntable will be shown, thus enabling visitors actually to see how this special engineering equipment operates in loading trucks with the correctly proportioned batches.

These miniature models of the hopper and measuring boxes will also enable visitors to see just how it is constructed and the simplicity with which it is loaded and dumped—also how the measuring boxes accurately measure the correct proportion of sand, gravel or cement. A noteworthy feature of these measuring boxes is that

they are adjustable to the varied sizes of loads desired by the contractor.

The miniature turntable will be exact in every detail to the actual turntable used on contracting jobs, and which completely turns a loaded truck around in less than 10 seconds.

Included in these quarter size models will be a quarter size replica of a Kissel Special Road-builders' truck—the idea of the manufacturers being actually to operate these four engineering features from the loading of the hopper to dumping the correctly proportioned load into the truck —the truck driving onto the turntable where it will be actually turned around preparatory to backing up to the mixer, where each batch is automatically dumped into the skip.

The special Kissel Road-builders" trucks are equipped with a hydraulic dump body of 3-batch capacity of 1 cu. yd. each, designed, geared and powered with the proper flexibility, power and speed for every economical service necessary to meet contractor's requirements.

In addition visitors at this exhibit will see how Kissel engineering service enables contractors to lay the greatest amount of finished road in the shortest time and at the lowest possible cost, enabling contractors to increase their daily footage at a decreased expenditure in time, labor and money.

It will be interesting to visitors to learn that the different Kissel road engineers will be in attendance at the exhibit throughout the length of the show. These are the engineers who supervise the trucks and equipment operating on a systematized schedule, keeping up a continuous flow of material from the hopper to the mixer, enabling the latter to operate every second throughout the working day. These engineers will have with them complete data and figures showing the economical and efficient operation of both the trucks and equipment and this together with the opportunity of visitors to see this equipment in actual operation, will be one of the most interesting events of the show.

NEW AUTOCAR MODEL AND PRICES

The Autocar Company of Ardmore, Pa., recently announced a new schedule of prices, effective Jan. 3, 1922, for its standard 1½ to 2-ton Autocar and for its 5-ton Heavy Duty Autocar. It announces also a new model Heavy Duty 2-ton Autocar.

The price of the standard 1½ to 2-ton Autocar, with its over-all capacity of 11,000 lbs., was reduced from $2,300 and $2,400 to $1,950 for the 97-in. wheelbase and $2,050 for the 120-in. wheelbase.

The new 2-ton Heavy Duty Autocar chassis, with a four-cylinder motor and an over-all capacity of 14,000 lbs., is priced at $2,950 for the 114-in. wheelbase and $3,075 for the 138-in. wheelbase.

The 5-ton Heavy Duty Autocar, with its over-all capacity of 22,000 lbs., is priced at $3,950 for the 120-in. wheelbase and $4,100 for the 156-in. wheelbase.

The unladen chassis weights of these six models are as follows:

Type F, 3,600 lbs.; Type G, 3,700 lbs.; Type H, 5,200 lbs.; Type K, 5,350 lbs.; Type Y, 7,200 lbs.; Type B, 7,400 lbs.

CONCRETE MIXER WITH ENCLOSED TRANSMISSION

Among the interesting exhibits in paving equipment at the National Roads Show to be held in Chicago, January 16 to 20, will be the 1922 model of the Rex Paver, manufactured by the Chain Belt Company, Milwaukee.

This is the machine which has attracted considerable attention during the past year because of its enclosed type of transmission. The Chain Belt Company is the first to have made use of this type of transmission, so successful with motor trucks, on paving machines. The enclosed transmission has proven highly successful on paving mixers.

Another distinctive feature that will attract the attention of highway contractors is the enclosed power-operated discharge of the Rex Paver. All gears operate in oil, so that the manipulation of the discharge chute is not only very easy, but also remarkably fast. The swinging of the chute responds almost instantly to the touch of the lever.

The Paver on exhibition will be equipped with the full-length type of traction adapted to the three-point suspension principle. A new type of Rex Distributing bucket will also be shown.

The company also plans to exhibit a central mixing plant mixer with features that are a radical departure from present mixer standards.

Concrete Road Building Breaks All Records

62,000,000 square yards of Concrete highway pavement—equivalent to 6000 miles of 18-foot road—were built last year. This is nearly double the amount built in any other year.

People demand roads which give the greatest measure of service, saving and safety. That is why highway officials everywhere are building Concrete hard-surfaced roads. They know from experience no other road performs like Concrete.

PORTLAND CEMENT ASSOCIATION

A National Organization
to Improve and Extend the Uses of Concrete

Atlanta				San Francisco
Chicago	Detroit	Los Angeles	Parkersburg	Seattle
Dallas	Helena	Milwaukee	Pittsburgh	St. Louis
Denver	Indianapolis	Minneapolis	Portland, Oreg.	Vancouver, B.C.
Des Moines	Kansas City	New York	Salt Lake City	Washington, D.C.

EDITORIALS

ADMINISTERING ENGINEERS' LICENSE LAWS

This magazine has always been in favor of engineers' license laws, believing that such laws, if properly formulated and administered, will raise the standards of engineering practice, increase the earnings of the competent engineers by gradually eliminating the incompetent, and protect the interests of the public. In our advocacy of licensing we always took for granted that when any state enacted an engineers' license law that all the engineers of the state would be granted licenses on application except in the case of individuals known to be dishonest or incompetent. In other words, it was our belief that changes resulting from licensing would be brought about gradually with a minimum disturbance to the existing conditions at the time the law became effective. We did not suppose that there would ever be a board, anywhere, that would refuse to issue a license to a man because he had long since forgotten certain academic knowledge in his preoccupation with affairs of consequence; we did not suppose any board would presume to say that certain engineers were practicing professional engineering while others in the same office engaged on the same tasks, but with junior titles, were not practicing professional engineering. Now we are dismayed to find that these faulty interpretations of license laws are working a hardship on individuals, are creating strife where only harm can result, are undermining the license idea itself and are threatening to do grave injury to the profession.

The subject is a large one and no attempt will here be made to consider its every aspect. We merely wish to point out, in all friendliness, that it is dead wrong, for example, to withhold a license from a thoroughly competent municipal and sanitary engineer who wants to design a water filtration plant for a city because he flunks when suddenly required, by a board of examiners, to design a crane for handling ore. It is also wrong to say that a city engineer is practicing professional engineering, but that his principal assistant, to go no further down the line, is not. It is also wrong to say that a man doing a certain grade of work for a fee is practicing professional engineering, while a man doing exactly similar work on a salary is not a professional engineer. These illustrations merely serve to indicate some of the perversions in administration which have come to our attention.

Nearly every engineer with whom we have discussed this subject feels quite convinced that the license laws will be repealed unless they are administered with common sense. Attempts to make their provisions retroactive in detail and to revolutionize speedily nearly all accepted professional concepts and usages will soon kill off these laws.

In our opinion the greatest danger arising from this maladministration is the attempt to divide engineers into "sheep and goats," to use a biblical allusion, with the goats very much in the majority. Let us be mighty careful how we handle the younger men in the junior grades of practical engineering work. They feel that they are practicing professional engineering and we emphatically agree with them. Can they be expected to continue to comport themselves as professional men if the constituted authorities of the state tell them they are not professional men?

The question does not concern the honesty or integrity of these boards; that they want to elevate the profession no one will deny. The question is merely as to the wisdom of certain practices which are beginning to take form. We urge the boards to proceed in a liberal spirit, striving for ultimate rather than immediate perfection.

STREET AND HIGHWAY LIGHTING

There is a new interest in highway lighting and a renewed interest in street lighting, due to motorized traffic. Cities once considered well lighted are revising their lighting systems as the normal pursuits of community life are being resumed. During the war lighting was sometimes not wanted at all, and in other cases existing facilities were considered

quite satisfactory for the time being. It was during this period, when little thought was given to lighting, that motorized traffic increased so rapidly, rendering inadequate the lighting systems which had served well enough for pedestrians and slow-moving horse-drawn vehicles.

The fact that motor vehicles carry their own lights adds to the difficulties of the problem, for such lights are often as much a menace to other vehicles as a protection to the one they are on. Every motorist has learned to dread the glaring headlight and also the tail light that is out of commission or which is not burning, due to the carelessness of the driver. Cars parked at the curb in the afternoon of winter days oftentimes remain dark long after nightfall and form dangerous obstructions in narrow streets. Many streets are so poorly lighted that the motorist's dim lights are insufficient and he is thus forced, in self-defense, to use his bright lights in a manner that adds to the total of traffic accidents. The remedy for this condition lies quite as much, or more, in improved street lighting as in the regulation of automobile lighting, which, like most attempted regulation of motoring, usually proves abortive.

While city lighting requirements have been changing, an even greater change has occurred on country highways, which have passed from thoroughfares on which lights neither existed nor were expected to ones requiring lights and having them, in a few cases. In fact, highway lighting is of more acute interest, in many ways, than street lighting at this time. That is, there is often greater need for at least a beginning in highway lighting than for improved street lighting. Fast motor traffic on dark and comparatively narrow country roads leads to many accidents and to much eye and nerve strain. There are circumstances under which it is flying straight into the face of providence for the motorist to refrain from using his bright lights, and, under such circumstances, he will continue to use them regardless of still-born headlight laws on the statute books.

It has been found that the installation of a thoroughly modern and adequate lighting system adds but a very small percentage to the first cost of a hard-surfaced road. It is unnecessary to enumerate the primary advantages of such a system, but there are secondary advantages of real importance which are deserving of consideration. To light a highway requires the running of a line out into the country, of course, and this brings electricity, with all of its benefits, within reach of many country homes. It is only a question of time when all modern roads will be patrolled by a state constabulary in an effort to cope with the miscreants who are now robbing with impunity. The efficient functioning of such a force will require good lighting.

We suggest to city officials that they investigate their street lighting equipment to test its efficiency under present-day requirements. Not only have conditions changed since many lighting systems were installed, but there have been advances in the art introducing elements of efficiency and economy which any city may adopt with profit to itself. It is urged, also, that serious consideration be given to the lighting of the more important highways carrying a heavy traffic.

BIND YOUR COPIES OF M. and C. E.

At the beginning of a new volume, with this number of Municipal and County Engineering, we are again urging our readers to preserve and bind their copies of this magazine. Articles of permanent value appear in each issue. The size of the paper, readopted one year ago, is well suited to binding, as it is substantially that of most of the text-books and catalogues that engineers and contractors keep on their book shelves.

It is suggested that after each copy is received and read it be placed where it can be found and subsequent numbers added to it. At the end of six months or a year it is a simple and inexpensive matter to send the copies to the binder to have them trimmed and bound into book form. Many readers, of course, have followed this practice for years, and they now have, in their bound volumes of this magazine, a comprehensive treatment of all phases of public works engineering.

The index for Vol. LXI, July-December, 1921, is now ready for distribution and will be sent free to any one who requests it.

IMPORTANT CONSIDERATIONS IN RECONSTRUCTING CITY PAVEMENTS

By Harlan H. Edwards, City Engineer, Danville, Ill.

(Editor's Note:—The present article calls attention to the fact that incidental work on resurfacing jobs may prove of major importance and describes a combination of concrete header curb with steel paving guard which proved successful along car tracks.)

Many of our city pavements laid down 25 or 30 years ago are getting to the point where they must either be rebuilt, or resurfaced with one of the several forms of bituminous pavement. Quite a few of these old pavements are of the block type which have either worn into chuck holes or have become rough by the settlement of the foundations under the increasingly heavy traffic. Some are old stone or gravel streets, some are of the bituminous type, while a few are of concrete, laid in the early days when "soupy" concrete was permitted. The "smoothing up" of these old streets constitutes much of the work of our modern street departments.

To rebuild or replace the wearing surface of most of these old streets is simple. In many cases merely the wearing surface is worn out, leaving thoroughly compacted foundations upon which new wearing surfaces may be placed. In such work no change of grade is involved, hence there is little work to be done other than strictly repaving.

Looking After Street Drainage on Resurfacing Jobs

When one undertakes to resurface a street, however, entirely new problems are introduced which are separate and distinct from the laying of the pavement itself. A new wearing course placed upon the old one brings the street and gutter level several inches above that of the original pavement, decreases the curb height and consequently the gutter capacity, and blocks the free drainage of surface water from intersecting streets and alleys to the street being resurfaced. It is seen, therefore, that unless the street in question is situated upon a ridge, with all cross streets and alleys draining away from it, the additonal problem of street drainage is injected into the proposed improvement.

A thorough and complete system of storm water drains is an essential part of nearly all resurfacing jobs. On account of the reduction in curb height, inlets or catch basins must be placed closer together along the street and their clear opening, free from all possible obstructions, be made large enough that all the water falling upon or flowing upon the street will be removed quickly in order that the sidewalks and basements of buildings adjoining will not be flooded. If this is not done, it is very likely that the city will be subjected to many lawsuits and claims for damages on this account.

Wherever new drains have been placed in the street, the trenches must be thoroughly backfilled, then spanned by a reinforced concrete slab having a bearing of at least 1 ft. on each side of the trench as dug. The surface of this slab is placed at the elevation of the old pavement. If this is not installed, settlement of the street at this point is inevitable.

In some cases it may be necessary also to lower alley turnouts before resurfac-

CONCRETE HEADER CURB CONSTRUCTION ON CAR TRACK STREET IN DANVILLE, ILLINOIS.

Left: Header Curb Protects Pavement while Track Structure is Being Replaced. Center: Header-Curb with Steel Paving Guard Holds Bituminous Top in Place. Right: Header-Curb with Brick Pavement. Note Condition of Pavements on Each Side.

ing, so that proper drainage may be accomplished, and in order that the paving be not placed above the sidewalk level. In many cases here, this necessitates the construction of a new foundation along this portion of the street, thus adding quite a little to the total cost. Additional drains and inlets can sometimes be eliminated in this way, the slope of the turnout being decreased somewhat thereby. At all paved intersecting streets and alleys, it is necessary to take up and relay the pavement from the end of the resurfaced street for a distance of about 10 ft., so that travel on these streets be not inconvenienced by a sudden rise or fall in the street level.

All of the foregoing items are things which must be done in the resurfacing of a street, but which are seldom mentioned when speaking of the cost of the improvement. In some instances it may be much cheaper to replace the old wearing course with a new one of similar material, keeping the street at its original elevation.

Using Header Curb in Resurfacing Car Track Streets

It is frequently the case that the street to be resurfaced is one of the principal thoroughfares, upon which a street car line is operated. Resurfacing such a street involves an additional item—that of raising the car tracks to conform to the new grade. In some cities the street railway company has been installing new rails and repaving without argument. In other cities, however, the railways have refused to assume this expense outside the cost of repaving, arguing that the expense was unwarranted and could be eliminated by replacing the old wearing surface with a new one without raising the grade.

In connection with this work, the use of the concrete header curb having a steel paving guard embodied in its surface has proven of great merit and value to everyone concerned—especially where bituminous surfaces have been placed upon the old pavements with granite block or brick in and along the car track. On North Vermilion Street, Danville, Illinois, a 6x24-in. concrete header curb having a 3x2x5/16-in. steel angle paving guard embedded in its surface, was built with its outer face 14 ins. outside the outside rails of the car track, and having the top of the paving guard at the grade of the new surface of the street. This was installed at a price of $1.25 per linear foot complete, using forms only on the face of the curb nearest the car tracks. The new pavement surface was laid, and opened to traffic before work on rebuilding the car track commenced. In this case full advantage was taken of the possibilities of this curb, for in the subsequent work, the car track was completely removed leaving a trench 20 ins. deep in which new ballast, ties, etc., were placed for the new track. The header curb formed the sides of the trench, relieving the car company from any trouble from that source, and protecting the city's pavement from any possible damage. This header curb has the added advantage of permanency, inasmuch as it is below the surface of the street, and receives no wear.

Encroachment of the car company beyond their franchise rights is prevented by the use of the header curb. In many cities the franchise of the car company calls for but 1 ft. outside the outside rail of the tracks. Upon investigation it is found almost invariably that the ties extend nearly a foot beyond this. The pavement along these tracks is usually in bad shape, while track maintenance men are found in some instances digging up the paving 6 to 8 ft. to the side of the track in order to remove a bad tie and put in a new one without taking up a rail. Such ruinous practice is entirely eliminated by the installation of the header curb. This type of curb is also obtainable in granite and wood block, making a very serviceable and unnoticed protection in streets of this character.

THE "RUTTING" AND "ROLLING" OF ASPHALT PAVEMENTS

By Hugh W. Skidmore, Consulting Engineer, Chicago Paving Laboratory, Inc., 160 N. Wells St., Chicago, Ill.

(Editor's Note:—This discussion places particular stress on the unwisdom of the indiscriminate use of standard specifications and calls particular attention to the relation between bitumen content and fine material. This represents one of the most important features of asphalt construction which now requires the sort of investigation and constructive criticism which will lead to the correction of faults in the use of this excellent paving material.)

Users of asphalt have lately become familiar with the expression, "Proved through the Ages," through the display of this appositive on the literature of the Asphalt Association. The fact that this material has demonstrated its durability implies a knowledge of its limitations as

well as of its adaptability, and indicates passage through the early or experimental stage of development. That is to say, a great deal has been learned as to where and how this very valuable material may be useful. In consequence of added knowledge pertaining to the various methods and means governing the use of bituminous cements, certain standards have been evolved. Changing service conditions from time to time have made necessary modification of standard practice.

Paving mixtures of 25 or 30 years ago—yes, of even 10 or 15 years ago, may not meet present-day traffic requirements. This is true despite the fact that many pavements are to be found which have been giving very satisfactory service for more than 30 years. The existence of a more or less limited yardage of old pavements which are still in a fair state of preservation, does not lead to the conclusion that certain modifications of old standards are not now advisable.

While it is sometimes necessary to resurface or replace asphaltic type pavements before a reasonable period of service has expired by reason of such failures as surface distortion, subsidence of subgrade, foundation failures, failure properly to replace openings in the pavement structure, etc., it is rarely ever necessary to relay an asphaltic pavement which has literally worn away. Thereore, there would seem to be ample evidence that either certain standards under which pavements have been designed may be improved or that such standards are not applied with a proper understanding of the modifications which may be necessary in order properly to meet existing service conditions.

By far the most serious criticism to be offered against asphaltic wearing surfaces, judged by their performance during the past few years, is the displacement of the composition under traffic. This defect may occur generally throughout a given piece of pavement, or it may be confined to limited areas. It does, however, exist to such an extent that the cause cannot be assigned to a few loads of paving mixture which failed to comply with the established formula.

Limitations Not Understood

The extent of "rutting" and "rolling" in some localities usually indicates just one thing—lack of definite understanding of the limitations pertaining to the use of asphalt as a cementing medium in its relation to the fine aggregates used in the pavement composition. Although slight variations from this proper ratio may not alone seriously affect the stability of the mixture when accompanied by the use of asphalt of suitable consistency—stability is greatly reduced during warm weather when too soft an asphalt is used. The reverse of this rule is not strictly true; i. e., a poorly balanced mixture may not be rendered stable solely through the use of an asphalt of suitable consistency.

In the great majority of cases it will be found that the cause of failure does not lie in the quality of the asphalt, and in no small number of cases it has been positively demonstrated that mechanical features of construction are either directly or indirectly the cause of pavement failure. Assuming that reasonably durable aggregates are used, density of finished mixture becomes the most important desideratum so far as longevity of the pavement composition is concerned. While it is true that the compressability of the mixture is largely dependent upon the grading of the mineral matter, it is also true that in a given mixture, much greater density is secured by the use of heavier rollers than are ordinarily employed.

Rolling

Another very important consideration in the matter of rolling which is not yet generally well enough understood by engineers and contractors, is the fact that the first rolling or surfacing of the hot mixture produces very nearly ultimate compression. Any mixture which will not sustain a roller of ten or twelve tons weight for the first rolling is improperly designed. There still seems to be a strong misconception in the minds of many to the effect that if the light roller performing the first rolling does not supply sufficient compression, subsequent rolling as the mixture cools will compensate for this deficiency. Although subsequent rolling may produce a certain amount of compression, the fallacy of the belief that such will be of any very great consequence is rapidly demonstrated by means of a comparison between the density of a mixture which has received only the first rolling and the same mixture after final rolling.

Blame Attaches to "Standard Specifications"

No small share of the blame for pavement failures falls upon the commonly termed "standard" specification. Any standard as applied to a structure at best represents only an average and requires adaptation to meet the needs of a specific case. The danger, of course, lies in the

possibility of the standard being applied literally. Certain standards are necessary and valuable as a working basis from which to develop suitable design, but the use of such standards is contingent upon knowledge of their limitations. Of all the so-called "standard" specifications, undoubtedly the old Topeka formula is the least reliable when construed literally. In fact, it is rather surprising that this particular specification should have ever acquired the name "standard." The very conception of this formula belies the logical sequence of experience through which standards are evolved. This mixture is not a true concrete conglomerate of either the coarse or fine mixture type, therefore it does not possess the necessary stability to withstand the traffic forces common to the average city pavement or arterial highway. Modification of this formula becomes necessary in order to insure reasonable durability except perhaps in cases where the pavement will receive only very light residential traffic. Either the mixture must have more stone and less bitumen or less stone and somewhat higher limits for the bitumen content, depending upon the intensity of traffic, kind of foundation and the use of a binder course. The coarser mixture prevails where no binder is used and the traffic is restricted to pleasure cars or is of low intensity.

Investigation of Defects in Pavements

Examination of "rutted" and "rolled" pavements in a number of cities for the purpose of determining the cause and advising a cure, has shown that in the great majority of cases mixtures have contained insufficient fine mineral and an excess of bitumen. The investigation in such cases should include a careful examination of the pavement and a study of the traffic conditions; analysis of the mixture; density of the mixture; consistency of the asphalt cement, and microscopic examination of the minerals used. It may be of interest to refer here to one or two of the actual cases which were investigated. In one city where "rutting" and "rolling" were very pronounced in both sheet asphalt and coarse mix asphaltic concrete; analysis of mixtures showed as high as 10 per cent bitumen in asphaltic concrete which carried only about 10 per cent of mineral passing the 80 screen, and as high as 14 per cent and 15 per cent of bitumen in sheet mixtures with less than 30 per cent of mineral passing the 80 screen of which less than one-third passed the 200 screen. In another instance an asphaltic mixture had rolled badly in certain portions; analysis of this mixture taken from the affected areas was as follows:

Bitumen	10.35%
Passing 200 mesh	10.62%
Passing 80 mesh	7.87%
Passing 40 mesh	21.10%
Passing 10 mesh	23.84%
Passing 4 mesh	21.47%
Passing 2 mesh	4.75%

There was such an excess of bitumen that a cross-section of the mixture exposed globules of pure asphaltic cement almost as large as a peanut kernel. The sample was taken after cool weather had prevailed for a short time and the effect of summer temperatures in drawing the bitumen to the surface was readily discernible in the cross-section.

Such examples as these illustrate inconsistencies in the proportioning of constituents as would quite obviously result in displacement of the mixture, but, when mixtures which at one time might have been considered "normal" are found to distort under severe traffic, the investigator is impressed with the fact that there exists a very delicate balance which must be maintained in the ratio between fine mineral and bitumen and that the limits of this ratio decrease as the intensity of traffic increases. In comparison with the analysis mentioned above, a sheet asphalt mixture was designed for the downtown traffic in a Western city with the bitumen from 10 to 10.5 per cent, stone dust passing 200 mesh screen, including a very small amount of fine sand, 18 to 22 per cent, and sand passing the 80 screen and retained on the 200, 25 to 30 per cent. This pavement was laid using three heavy rollers. A very smooth surface and high density resulted. In another city where a heavy traffic mixture was designed, the first rolling of the sheet asphalt was effected by a 3-wheeled roller weighing 12 tons. The two 8-ton rollers finishing readily removed all of the roller marks left by the 3-wheeler. Asphalt of 35 to 40 penetration was used in both of these instances.

Consistency of Asphaltic Cement

The intensity and weight of traffic are the controlling factors in establishing the working consistency of the asphaltic cement. Except in extreme cases, there is little if any call for penetrations to be lower than 35 to 40, or higher than 60. This statement applies to mixed type pavement, and includes the binder course in which the asphaltic cement should have

the same consistency that is set for the top course. Often there is too much importance assigned to the matter of variations in penetrations. While it is true that the consistency of the asphaltic cement is an important factor in the manufacture of an asphaltic wearing surface, restriction as to the limits is frequently very much overdone. In the first place, when asphalts are fluxed at the paving plant, the penetration cannot be controlled within very narrow limits except by the expenditure of more time and effort than practical purposes require. Secondly, in a properly proportioned mixture which carries sufficient fine mineral matter for the traffic, five or six units of fluctuation in either direction from the working consistency will not be a serious matter so far as the durability of the mixture is concerned; provided that in the first place the working consistency was set low enough.

Application of Knowledge Gained by Investigation

The knowledge obtained from thorough investigation of pavement failures, if properly used, will prevent the duplication of the same mistakes in future work, and may very well indicate the means of correcting errors in the pavement under investigation. Work along this line has been done by the Chicago West Parks in connection with asphaltic concrete pavements on boulevards which have rutted. The mixtures were first analyzed and the deficiencies noted: the wearing surface in the affected areas was then removed and run through a reheating plant, where the deficient materials were added and the mixture was relaid. Sections of pavement so treated thus far indicate that the structural weakness which permitted the displacement of the composition has been corrected. This work, although on so small a scale as to make impossible construction economies, was done at a cost very much less than the cost of resurfacing. When a defective mixture can be so easily corrected, at a cost much less than the cost of resurfacing or relaying, a great saving is offered to taxpayers by this means of protecting their original investment. An asphalt pavement only five or six years old has a potential additional life of 10 to 15 years or more. This being true, the possible saving to be effected by remixing any portions which in the early years develop "waves" and "ruts," is readily apparent.

INSPECTING MATERIALS USED IN CONSTRUCTING ILLINOIS HIGHWAYS

By H. F. Clemmer, Testing Engineer, Illinois Division of Highways, State House, Springfield, Ill.

With the introduction of the immense highway building program in 1918 which called for hundreds of miles of paved roads involving the expenditure of millions of dollars, Illinois was faced with the problem of securing efficient inspection of road materials. So satisfactory has this problem been solved that no change from the present system is mentioned in the outline for construction for 1922, which calls for the building of far more miles of paved roads than have ever before been built in one year by any state in the United States or single province of a foreign nation.

Field Inspection

Field inspection of highway materials in Illinois on a large scale began in 1919 when construction was started in this state on inter-state roads such as the Lincoln, Dixie, Chicago-Milwaukee, National Old Trails and Chicago-St. Louis Highways. Previous to this time the testing of road oils, asphalts, paints, creosoted wood blocks, bricks, steel and cement was accomplished by a small but efficient staff of engineers at the Highway Testing Laboratory in Springfield. The advent of construction such as the building of inter-state highways necessitated a system which would facilitate the testing of thousands of cubic yards of materials in the field. To meet this need, inspectors were placed over different sections of the highways under construction to travel back and forth inspecting the material as it arrived, and make reports each day to the Highway Testing Laboratory in Springfield. Cement was inspected at the seven mills supplying it by junior testing engineers who made their tests as soon as the material was loaded and immediately sent the reports of its acceptability to the resident engineers. During the year 1919, 299,329 yds. of sand, gravel and crushed stone and 751,489 barrels of cement were inspected with exceptionally good results.

Inspecting Aggregate

In 1920 a decided change in the method of inspecting aggregate was adopted. Inspectors instead of being placed at construction sites were located at the source of production. This system permitted the installation of inspection equipment of a more permanent nature, insuring in

some degree better facilities for making a more thorough inspection. Perhaps the greatest advantage in adopting the "production site inspection" lies in the fact that rejection of unsuitable material at construction points is eliminated and consequently a saving in time and expense is experienced by the material man, the contractor and the State. Though materials producers realize that specifications must be adhered to, the rejection of aggregates after they have been loaded and shipped to the construction site produces an irritation which does little to promote harmony in business relations. Illinois, however, was not led to make this change in system of inspection by any "good fellowship" feelings but rather by the benefits which she herself would derive. Though a slight increase in inspection cost was noted, savings along other lines more than eclipsed the added expense. A hastening of construction was apparent immediately. The materials men knew that when the car of material was shipped it would be used; the contractor knew his material passed specifications and preparations to use it immediately upon its arrival could be made without hesitancy; the State resident engineer could carry on his work without fear of hurry-up calls for inspectors and the resulting squabbles of rejections.

Under the new system, materials from 69 plants in this and neighboring states were inspected. Over 690,000 cu. yds. of sand, gravel and crushed stone passed the tests made by the inspectors. During this year inspection was carried on at nine cement plants, 1,281,537 barrels of the product being tested.

District Testing Engineers

At the beginning of the 1921 construction season an improvement was made on the already satisfactory system of inspection. District Testing Engineers—men with considerable experience in highway materials—were permanently located at district engineers' headquarters. The duties attached to this office are to supervise the work of the inspectors in the different districts and to co-operate in every respect with the district engineers in their efforts relating to materials. The testing engineers also visit construction sites, confer with contractors and see that material troubles are cleared up in a quick and efficient manner. The value of organization was truly shown when, after adjustment to the new arrangement, a remarkably smooth running inspection "machine" has resulted, which, strange as it may seem, has proven satisfactory to every one connected with the construction of Illinois highways. Inspectors are able to settle small difficulties in little time. Long and repeated correspondence has given way to the short telegram or card to the district testing engineer. The written letter was replaced by the face-to-face interview which brings far better results and leaves behind a much better feeling. District engineers are able to take up their materials troubles with one person instead of twenty. The Testing Engineer at Springfield is not called upon to settle minor troubles at a hundred places, but in conference with 9 men he controls the inspection activities at all plants furnishing materials.

During the first eight months of 1921 over 650,000 cu. yds. of aggregates were inspected for use in Illinois highways. This material came from 80 different plants in Illinois and surrounding states. Cement aggregating over 910,000 barrrels was also tested during this period of time by junior testing engineers located at 12 different mills.

Cost of Inspection

It would appear that inspection as thorough and on such a large scale as carried on by Illinois could not be economically maintained. A careful accounting of the costs of inspection during 1920 was made and, including the laboratory expense, was found to be a trifle less than 0.7 of 1 per cent of the construction costs. A slight increase is expected in 1921 but it is thought that the most liberal estimate will still keep the costs under 1 per cent of the construction expense. With inspection as efficient as maintained at present, such an expense is easily justifiable.

Inspecting Steel

The advantages of inspecting material at the source of its production was so pronounced that it was decided to attempt this method in inspecting steel. An inspector was stationed in Chicago early in the spring of 1921 and the results of his work were gratifying to such an extent that the Department maintained this system of inspection throughout the year, and intends to continue it in the future. Mill operators as well as contractors are particularly pleased with the present system, and difficulties have apparently ceased in the inspection of this type of construction materials.

The Making of an Inspector

The success of Illinois inspection system is based, in a great measure, upon the type of inspector and the training he has had and gets before he is sent in the

field. Technically trained men make up the greater part of the field force, but whether these men are engineers or not they must have one qualification which has proven to be essential to the success of an inspector—personality. At its best, inspection work is of a nerve-trying nature with the materials men at the disadvantageous position. To be able to reject material and still "get along" with the men in charge is a characteristic which an inspector in the Bureau of Tests of Illinois must possess.

In spite of what engineering development a man may have had, when he comes to this Department he must go through a regular course of training before he is placed on a job. This training occupies a week and is carried out in the Laboratory at Springfield. A thorough course of inspection involving difficulties which may come up in the field, laboratory and construction site, is given each prospective inspector. A knowledge of the system of records is also required, as well as the making up of daily reports. After the course of training has been completed, a rigid examination, which includes the various phases of inspection work, is given the candidate. A passing grade must be obtained before any person is retained as an inspector. When a new inspector goes into the field, the district testing engineer stays with him until he is quite familiar with the work.

Testing Aggregates

In testing aggregates at the plants, samples of the material are taken from each car to be shipped. These samples are given a mechanical analysis, a silt analysis and a visual inspection. The mechanical analysis, made with standard screens, determines the gradation of the aggregates. The visual inspection is made for the purpose of "spotting" shale, shells and other soft material. Each inspector is required to send in to the main office a daily report on material inspected and shipped. The report contains the results of the tests made, the quantity of the material shipped, the source of its production and the contractor to whom the material is consigned. These reports are made up in triplicate form; one to go to the main office, one to the district engineer and the third to the resident engineer of the section to which the material is consigned. Upon receipt of the report the resident engineer fills out that portion of the report which pertains to the section number, the county and the route where the material is to be used.

Working in conjunction with the field force of inspectors is the testing department of the laboratory at Springfield. Previous to the placing of the proper equipment at production points and the locating of inspectors at these places, the laboratory was called upon to test all material of which there was the slightest doubt. Under the new system only special cases of testing are handled in the laboratory. At the opening of any new sand or gravel pit, stone quarry, or cement mill which is to furnish material for Illinois highways, samples of the product are thoroughly tested in the laboratory. Also at the beginning and at the end of each construction season, samples from all plants which supplied material during the year are given "quality tests." These tests, in the case of sand and gravel, include sieve analysis, washing, wearing qualities, organic material content, and other standard tests. Rock is tested for wear, specific gravity, absorption, hardness, toughness and cementation value. Cement is given a chemical test, besides tests for soundness, time of set, fineness and tensile strength. All tests are kept in a permanent record book, and serve as checks on the quality of material produced.

A DRAINAGE EXPERT'S IDEAS ON HIGHWAY CONSTRUCTION

By Edgar A. Rossiter, Consulting Civil Engineer, 127 N. Dearborn St., Chicago, Ill.

(Editor's Note: Our contributor here makes a forceful presentation of a recommended revision of highway drainage practice. He joins us in the hope that this article, written in a spirit of constructive criticism, will lead to an interesting and helpful discussion.)

Our technical papers, books and magazines for the last ten years have been filled with articles relative to Highway Construction, and inasmuch as there will be more money spent in the construction of roads during the coming decade than in any other form of construction, a complete understanding and enlightenment of the subject is desirable and of the utmost importance.

To the layman many of these articles are but a pitiful confession of ignorance of highway construction by their authors. Even the professor sometimes holds up his hands in humble supplication to be free from the machinations of the politicians and his prayer for a million dollars for research and experiment is an excruciat-

ing and painful acknowledgment of his lack of knowledge and vindication of the politician's lack of faith in his ability or recommendations.

Approximately eight hundred million dollars is in sight and available for state, county and federal highway construction. Is there not one master mind of construction, not one eminent highway engineer, who can step to the front and fill our pages with how to build and to build right?

A certain highway engineer said that we could not tell him anything about building roads as he had been engaged in that business for 25 years, but when asked if he could show one single mile of road that he was especially proud of in his territory, he had to admit that he could not. How many others can? Is it not true that, "By their works ye shall know them?" If battleships were made in the same manner as some highways they would crush in with their own weight; if skyscrapers were built in a like manner many would not survive to be roofed; if engines were to be designed with as little knowledge of the subject matter as highways are constructed heaven knows what they would or would not do.

The Naval Architect, the Structural Engineer, the Mechanical Engineer need no apology when in the design of their work they include a question of foundation and a study of all the elements entering into the making and use thereof. The railroad engineer years ago discovered that foundations were the essence of travel and he did not hesitate to change his plans as each class of soil was reached. The drainage engineer at one time tried only to drain the low lands, but as his knowledge broadened, he found that the high lands contained pockets of water-bearing sand, and syncline basins, filled with water, were encountered even in the foothills and higher lands.

As the sub-soils govern the foundation of the buildings and other structures whose footings reach below the frost line and often reach to rock, is it not only reasonable to expect that the Highway Engineer should take into consideration every element that enters into good road construction and wherever possible prepare his foundation to a point below the frost line?

An eminent authority writes, "Our pavements float above the frost line, often on a sea of mud whose strength or behavior we know nothing about and in addition we are compelled to shave close to ultimate strength," and yet we place eight hundred million dollars in the hands of such men to construct highways. If men know these facts and yet do not have the moral courage ot their convictions and knowledge to shout them out to the world, what must we expect of the politician or farmer roadmaster to whom their recommendations are submitted?

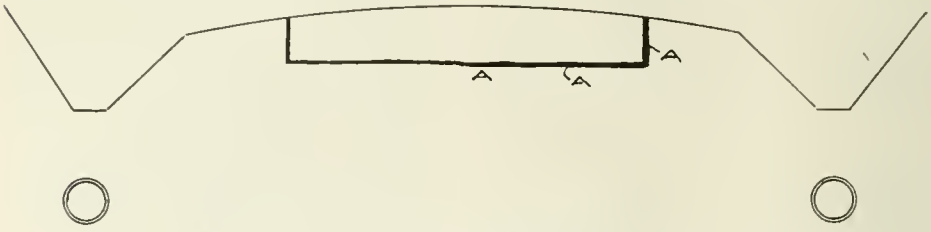


FIG. 1: COMMON TYPE OF ROAD DRAINAGE CONSIDERED FAULTY BY DRAINAGE EXPERT.

The Figure Indicates an 18 ft. Concrete Roadway, with 6 ft. Built-Up Shoulders and Side Ditches 2 or 3 ft. Deep. The Tile Drains Shown Would be as Serviceable if on the Telephone Poles as in the Position here Indicated, in the Opinion of the Author. The Shading Indicates the Capillary Movement of Water on the Subgrade.

Highway engineers have been very profuse in the assertion that the causes of various cracks in concrete pavements are unknown, but let us reason from the standpoint of the Drainage Engineer, Elliott in his treatise on drainage, labels water as Hydrostatic and Capillary. And it is a drainage axiom that dry material, when frozen, does not heave, swell or shrink; therefore, let us take the average 18 ft. concrete roadway, with built-up 6 ft. shoulders, with a 2 to 3 ft. ditch, to drain the roadway as shown in Fig. 1.

What is the resultant of storm forces on such a plan? The heavy storm water which pours down in torrents, runs off over the pavement and shoulders and passes away in the drains and ditches we will call the hydrostatic water. It does no special harm. But what becomes of the capillary water, the slow running water that slides over the pavement, with no special velocity and drips down along

the edges of the concrete and soaks under the concrete; even follows the line of the concrete over the well rolled subbas, at first possibly only for a few inches, but gradually at each succeeding shower until quite an area is covered? See Fig. 2. What happens?

It is quite evident that it will begin to puddle and settle every time a team or truck passes over it until a truck will pass, whose weight is equal to the tensile strength of a certain line of concrete when the break will occur. The break

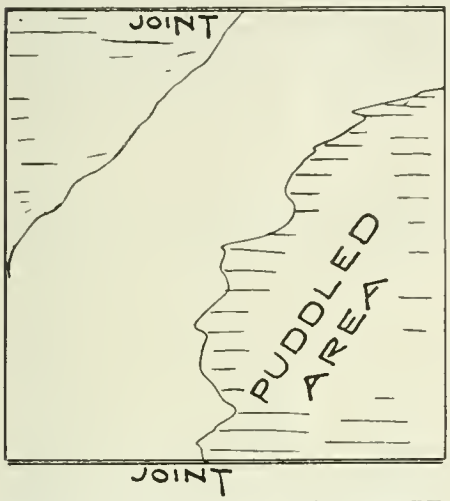


FIG. 2. PLAN OF SUBGRADE BETWEEN TRANSVERSE JOINTS SHOWING PUDDLED AREA DUE TO SEEPAGE OF CAPILLARY WATER BETWEEN PAVEMENT SLAB AND SUBGRADE.

need not follow the line of the puddle but will travel in the line of least resistance. During the construction and after the rolling you will find that all the hauling has been done in the center of the 18-ft. space and generally the subgrade is lower than the edge which gives the capillary water a good chance to flow to the center of the road; this water settles the sub-grade, leaving the slab unsupported.

In Fig. 1, drain pipes are shown which might as well he on the telegraph poles as far as any good the concrete pavement will derive from them; but this is the way some highway engineers have "doped" it out. Quite frequently the cut for the sub-grade is made leaving the finished pavement between two shoulders of native soil which again aids the capillary water In undermining tbe finished work.

Then, again, in the grades over a hill sometimes even on fairly steep grades the Highway Engineer will say, "There is no need of drainage." But the Drainage Engineer has learned the meaning of impervious soils and he knows that beyond such walls, pockets of quick-sand or rather, floating sands, puddles of plastic clay, are to be found. These impervious soils form syncline basins, sometimes reaching through subterraneous channels for thousands of feet and through these channels are drained the catchment area of many acres of land and the drainage engineer will tell you that even the hillsides need drainage.

Some departments have done away with the expansion joint, claiming that the concrete will crack anyway so let it crack where it will. If we eliminate the cracks due to the lack of drainage and puddling of slabs, then assume that we build a continuous slab for one mile and fasten the ends so that it can not move, what happens at a drop in the temperature of 50 to 60 degs. (friction not considered)? Will it take a mathematical expert to tell us that the forces of nature will break the slab, as often as the tensile strength of the concrete is equal to the weight of a certain section of the slab and that we will have as many cracks as the total weight is divisible by the tensile strength of a cross section of the slab and that we will have about 157 cracks per mile? Did it ever occur to the engineer that when that great force is exerting its strength to the ultimate breaking point that it is weakening every foot of the pavement subject to such a stress?

The stability of pavements depends on "how firm a foundation" and most highway engineers, like the old colored preacher, are satisfied to leave it to the Lord. If it is true that dry material will not expand, shrink or swell when frozen, then it is a simple question of obtaining a dry foundation down to a frost line. This can be obtained by laying lines of tile on the outer edges of the 18-ft. roadway and filling the trench with the same material, then by rolling the space between the drains to an unyielding surface. I would even slightly curve the sub-grade. Did it ever occur to the highway engineer to form a drip under the edge of the concrete to lead the water down the drain instead of under the concrete? See Fig. 3. These drips are constructed in every window sill or water table, and would it not be advisable to adopt them in road making?

My attention was called to a mile of concrete pavement having expansion joints and the report was that there was not a single crack for one mile. I know the location. The concrete was built on

sand, which gave an unyielding foundation, perfect drainage and a cushion. Nature has provided what engineers must supply where good roads are to be built.

If a concrete road built on sand gives an unyielding base by reason of the drainage afforded, eliminates the upheaving of the work, and forms a cushion, are they not the elements that are inductive to good road-making? We drift back to the axiom that dry material, in freezing does not swell, shrink or expand and if our sub-base is constructed with these elements we will have good roads.

If we can eliminated puddling and a shifting sub-grade by good drainage, so that the foundation can carry a uniformly distributed load or even a shifting load without cantilever action, or beam stresses, and then place expansion joints within the elastic limits of the concrete, does the highway engineer suppose that we would have the cracking that now takes place? Would not such construction reduce cracks to 10 or 15 per mile instead of the prevalent 150 to 180?

For some reason State Specifications are generally alike throughout an entire state, no matter whether the road passes through rocky hills or through swamps and low lands. No private enterprise would entertain such a condition. Specifications should be adapted to meet the local conditions and foundations should be prepared to the end that the wearing surface could carry the load. In some cases special foundations should he constructed and used for a year or two before the finish surfaces are placed; drainage and foundation requirements apply whether the road be built of concrete or any other material.

When Highway Engineers are in a position to tell the public how to build good roads, public opinion will demand that the best be constructed. There is a way to construct good lasting roads but they cost money.

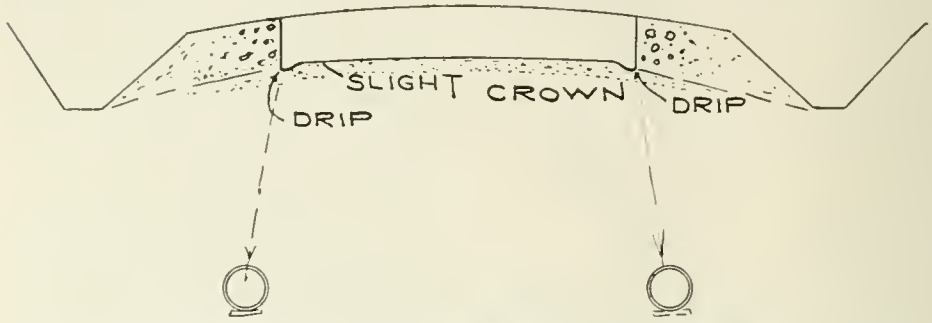


FIG. 3. TYPE OF ROAD DRAINAGE RECOMMENDED BY A DRAINAGE EXPERT.
The Lines of Tile are Placed at Outer Edges of Roadway; Space Between Trenches is Rolled to an Unyielding Surface; Subgrade Slightly Curved; Drip is Formed Under Edge of Concrete Slab to Lead Water into Drains Instead of Under the Concrete.

CONSTRUCTING KENTUCKY ROCK ASPHALT PAVEMENT ON DIXIE HIGHWAY BETWEEN LOUISVILLE AND WEST POINT, KENTUCKY

By J. H. Cahill, Contractor, Louisville, Ky.

The completion of the Dixie Highway from Louisville to Camp Henry Knox, at West Point, Ky., has been a matter of great satisfaction, not only to Kentuckians, but to thousands of tourists. This highway is really the gateway to the South, carrying almost all the automobile traffic from the upper Mississippi Valley. Probably no road south of the Ohio river is subjected to such heavy traffic.

The section just completed is a macadam base with a Kentucky rock asphalt surface, and replaces an old macadam road constructed several decades ago. The improvement begins about 8 miles from the city limits of Louisville, the terminus of the rock asphalt section constructed in 1915-16, and extends for a distance of approximately 11 miles.

The old macadam road, as originally constructed, consisted of a first course of sandstone and soft limestone broken to a size of about 6 ins. Over this was placed a course of broken limestone and clay, the surface being leveled and compacted by traffic.

When the road was originally constructed, very little attention was given to line and grade. It was, therefore, necessary to relocate the road in several places and lay a smooth grade line. The old road was subjected to overflow for a distance of about 2 miles near West Point.

SECTION OF ELEVEN-MILE EXTENSION OF DIXIE HIGHWAY WITH KENTUCKY ROCK ASPHALT SURFACE AS DESCRIBED IN THIS ARTICLE.

This necessitated the building of a high fill, which it is believed will place the new surface above all except extraordinary high water, such as that experienced in 1913.

The new grade was laid so that the old stone base could be used as much as possible. Owing to the fact that very fine stone, dust and earth compose as much as one-half of the base, the thickness was measured every few hundred feet and the effective depth considered equal to 50 per cent. of the measured depth. Sufficient stone was then added to make the total compacted thickness of the base 9 ins. The old surface was only 16 ft. wide. The new surface is 20 ft. in width. The old surface was scarified and shaped to 20 ft., the extra 4 ft. being added on one side only. Stakes were set to enable the contractor to get the proper grade and cross-section, and stone from the old surface was moved to the extra 4 ft. in sufficient quantity so that after compacting the entire 20 ft. would be covered with the same depth of old metal. Shoulders were then thrown up by excavating along the sides. Shoulder drains were constructed of broken stone at all low places in the road.

The first course was built a total depth of 7 ins. compacted, sufficient new stone being added so that when combined with the stone in the old base, it would equal 7 ins. All stone used in this course passed a 3½-in. screen and was retained on a ¾-in. screen. Trucks equipped with an end dumping device were approved as a satisfactory means of spreading stone. Stakes were set at a sufficient number of points across the road and the contractor spread the stone loose to the top of the

VIEW ON DIXIE HIGHWAY JUST SOUTH OF LOUISVILLE, KY. KENTUCKY ROCK ASPHALT ON OLD MACADAM BASE LAID IN 1915-16. PHOTOGRAPHED DECEMBER, 1921. THIS ROAD CARRIED 4,000 VEHICLES A DAY, MOST OF THEM ARMY TRUCKS, DURING THE WAR.

stakes. Two or three men with stone rakes smoothed the stone surface, after which it was lightly rolled, and screenings, ranging in size from ¾ in. to dust, were spread over the base and each layer rolled dry. This process was continued until the screenings were flush with and not above the top of the rolled stone. The surface was then thoroughly wet and rolled at the same time, sprinkling and rolling being continued and additional screenings added, where neecssary, until all voids were filled and the metal well bonded. No excess screenings were allowed on top of the surface, the aim being to leave the screenings slightly below the surface to provide anchorage for the second course.

The top course was built a thickness of 2 ins. compacted. Stone for this course was required to pass a 3½-in. screen and be retained on a 1½-in. screen. Stakes were set at the edges, quarter points and the center every 25 ft. along the road. The contractor spread the stone to the top of the stakes. This stone was spread from trucks and leveled by hand, using stone rakes. The stone in this course was thoroughly rolled, but no screenings were applied, the voids being left open to afford good anchorage for the rock asphalt.

After the second course was completed, edge boards were set to line and grade and Kentucky rock asphalt spread over the stone base. The asphalt was hauled in trucks and dumped on planks placed on the second course. The asphalt was spread by hand from the dumping board, carefully raked and finally smoothed by

DUMPING ROCK ASPHALT ON BOARDS WHICH ARE MOVED FORWARD WITH THE PROGRESS OF THE WORK.

the use of a template. The material near the edge boards was tamped down, the edge boards removed and the earth shoulders placed against the asphalt. The entire surface was then rolled, the rear wheel of the roller overlapping the shoulder about 6 ins. The first rolling consisted merely in passing over the asphalt once with a 10-ton 3-wheel roller. The second day it was rolled three or four times and the third day rolled as much as thought necessary and then cross-rolled with a 5-ton tandem, to remove any small waves and marks from the roller wheels. This type of surfacing gives a good wearing surface above the stone, and, in addition, all voids in the open stone base are filled for a depth of about 2 ins.

The writer, who was the contractor on the work, made some records in constructing the surface which are considered extraordinary. On June 16, 1921, the crew of 16 men laid 1,275 lin. ft. of Kentucky rock asphalt in 10 hours. This crew consisted of 4 rakers, 5 forkers, 4 men who handled the dumping boards and 3 men to place the edge boards. As the haul to the asphalt storage was short, one truck handled all the material.

The Kentucky rock asphalt used for surface was produced in Edmonson County, by the Kentucky Rock Asphalt Company, of Louisville. It is quarried and

TYPICAL APPEARANCE OF TOP COURSE OF STONE SHOWING VOIDS LEFT OPEN TO GIVE ANCHORAGE FOR ROCK ASPHALT.

crushed in a similar manner to ordinary limestone; pulverized to about the consistency of coarse meal; loaded in barges at the plant and towed about 70 miles to Bowling Green, the railroad terminal. It is then loaded in open-top cars and shipped, ready to lay cold.

For unloading the asphalt, we used a Byers Auto Crane equipped with a ¾-yd. clamshell bucket. Owing to the car shortage, several cars were unloaded and stored before the actual work of construction was undertaken. This method insured material constantly on hand, and it was found that the material was easy to handle from the storage piles.

In order to place the road above high water, it was necessary to build a heavy earth fill as high as 25 ft., in some places. This fill, with the extra material moved to allow people living along the road to reach the new road, totaled 242,000 cu. yds. The fill was built with a Marion Drag Line, equipped with a 2-cu. yd. bucket. Owing to the fact that the fill was not rolled or otherwise compacted, 25 per cent. was allowed for shrinkage. A water-bound macadam surface was placed over the fill, no attempt being made to lay the rock asphalt until the fill has thoroughly settled and compacted.

CONSTRUCTING STANDARD TYPES OF ASPHALT PAVEMENTS

By W. L. Hempelmann, Engineer, Asphalt Sales Department, The Texas Co., 10 S. LaSalle St., Chicago, Ill.

Asphalt materials find a use in many other types than those commonly included under the name of asphalt pavements, and such other wearing surfaces often depend upon the proper functioning of an asphalt material in obtaining a satisfactory pavement. We all know how important the proper filler and expansion joints in a concrete, wood block or brick pavement become when climatic changes bring corresponding changes in such surfaces, the rupture or destruction of which may depend upon the asphalt material doing its part. Carrying the analysis a little further, we find that the country becomes more and more desirable and inviting as the dust on such connecting highways, for the most part not permanently improved, is reduced to a minimum by proper treatment with an asphaltic product.

Not including surface treatments of any kind, asphalt pavements can be divided into three types, namely, Asphalt or Penetration Macadam, Asphaltic Concrete and Sheet Asphalt. All are produced by combining an asphaltic material in certain proportions with various graded aggregates, either on the job or in specially designed plants.

An Asphalt Macadam roadway consists of a base of suitable thickness, such as Telford, broken stone, etc., and the construction thereon of a penetration macadam wearing surface. Such base should be 6 to 9 ins. thick, thoroughly compacted on a thoroughly rolled and drained subgrade. Drainage has been preached so long that every one knows the importance of this very important good roads item, and practically all the experience on any type of road applies equally well to all other types under similar conditions, due allowance being made for the difference in the wearing surface.

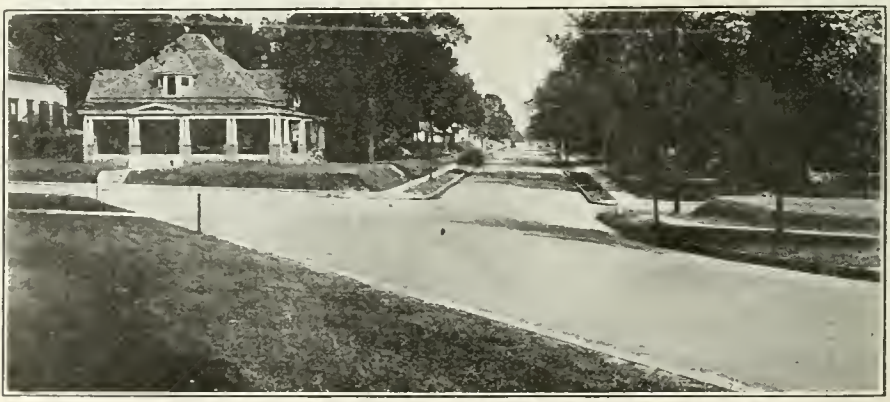
BRICK PAVEMENT WITH ASPHALT FILLER ON MAIN STREET, GALESBURG, ILLINOIS, AFTER SIX YEARS' SERVICE.

GRAVELLED BUSINESS STREET IN SAN MARCOS, TEXAS, TREATED WITH LIGHT ASPHALTIC ROAD OIL, AFTER THREE YEARS' SERVICE.

Type I—Asphalt Macadam

To a large extent the success of an asphaltic macadam pavement depends upon the stability of a thoroughly rolled and bonded base. Over the properly prepared base screened broken stone is spread to a depth of from 2½ ins. to 3 ins. after compression. This wearing surface stone should be tough, hard, durable and free from surface stone, from 1½ ins. to 2½ ins. in size and substantially free from dust. Stone of uniform size and wearing qualities is absolutely necessary for the construction of a satisfactory wearing surface. Everything else being equal, the harder the stone the better the surface, but soft stone has been used in a fairly successful pavement, though results obtained with combinations of the two usually proved unsatisfactory. Prior to the application of the asphalt binder, the wearing course of stone should show a uniform open surface. Mechanical pressure distributors are to be preferred for applying the asphalt binder, though many miles of successful penetration macadam have been poured with hand-pouring pots. As nearly as possible, every square yard of surface should receive the same amount of bituminous material, which will depend on the grading inch of depth of wearing surface. After application, no stone should be visible. The temperature at which the binder is applied will vary with the nature of the material used, and in any case it must be very liquid to find its way to the bottom of the wearing surface before congealing. For best results the stone should be clean and dry and the atmospheric temperature high.

Immediately after applying the binder, dry, clean durable stone chips, varying in size from ¼ to ¾ ins., should be spread evenly over the surface and then rolled. The rolling intended to force these smaller stone particles down and between the wearing course stone and in a manner strengthen the mechanical "keying" of the stone. Such surface should show stability under the roller and not wave. After rolling, the surface should be thoroughly swept until free of all surplus fine



ASPHALTIC CONCRETE PAVEMENT ON HICKORY STREET, TEXARKANA, ARK.

mineral and the seal coat of asphaltic material applied, which will vary from ¼ to ¾ gals. per sq. yd. of surface. Stone chips as above are then evenly spread over the surface and rolled, after which the roadway may be thrown open to traffic. Where local durable stone is available this is one of the most satisfactory and moderate priced pavements.

Again this is a very popular method for resurfacing old macadam highways where the depth of such macadam is sufficient to form a satisfactory base, requiring only 2½ to 3 ins. of penetrated stone for a practically new pavement. Resurfacing old macadam is recognized as a type by the American Society for Municipal Improvements whose standard paving specifications are well known in the highway building field.

In the penetration macadam pavement we aim to build a dense stone and asphaltic wearing surface, in which every particle is thoroughly coated and in which all particles large and small are held in place by a satisfactory asphaltic binder.

The fact that satisfactory penetration macadam pavements can be constructed without expensive equipment and with a corresponding lesser overhead charge, makes this type of construction very popular with the smaller contractors and in communities where the roads are not subject to excessively heavy traffic. For the small jobs a melting kettle and a pouring can constitute the added equipment.

Type II—Asphaltic Concrete

Asphaltic concrete represents the next higher type of asphaltic construction. As the name implies this represents a mixture of coarse and fine aggregates cemented and held together by a suitable asphaltic cement. This in the main requires a specially designed plant capable of heating and combining stone, sand, mineral dust and asphalt in definite and fixed proportions, the hot mixture being conveyed to the job by motor trucks or wagons, when it is dumped, spread, raked and rolled to the required depth on a suitably prepared base. Tough, durable stone, as nearly cubical in shape as possible, should be used. To this is added fine stone, and mineral dust, varying in size from impalpable powder upwards and all particles, large and small, are coated with a film of asphalt of substantial thickness. Proportioning of the ingredients is done by weighing, the temperatures being under thermometer control. By proper proportioning of the ingredients a dense, practically voidless mass is obtained when this hot mixture is compressed by the roller on a suitable base. Hot mixed asphaltic concretes have been used for many years, the most popular type today being known as the Topeka Mix, because of a coarse mineral aggregate pavement laid about ten years ago in the city of Topeka, Kas., by the Kaw Paving Company. Asphaltic concrete pavements are in use under all kinds of traffic and climatic conditions, and giving satisfactory service. This moderately priced pavement represents one of the most economical types, and may be laid over old macadam or Portland cement, or asphaltic concrete, as a base. The consistency of the asphalt used will depend upon the climatic conditions, and the nature of the traffic.

In general three methods are employed to make a hard pavement: first, by the use of a hard asphaltic cement; second, by a high per cent of 200 material, and third, both hard asphaltic cement and high per cent of filler.

All bituminous pavements, as well as all others, are influenced by temperature changes, only in a different way. Proper grading of the aggregate held together by an asphaltic cement not seriously affected by temperature changes gives the required stability to such mixture. In every case the desirable pavement is one which will be hard enough not to crack by contraction during the winter. This property is furnished in the main by a suitable asphalt. The average Topeka mix closely resembles a sheet asphalt mixture to which approximately 25 per cent of fine stone has been added, the stone serving the double purposes of hardening the mixture and lessening the cost. Because of the stability of this mixture produced by the stone, the binder course is required under this wearing surface as is the case with the standard sheet asphalt type of construction. The above features have resulted in producing a wearing surface, the cost of which is so moderate and the serviceability so great that it has become and will remain one of the most popular pavements for city streets and highways.

Old macadam roads, of substantial thickness, but in need of repair, have been very successfully and economically resurfaced with asphaltic concrete wearing surface. It easily represents the most economical hard surface pavement applicable in the resurfacing of old macadam, worn out block, and concrete pavements. By strict attention to essential details in construction, holes, cracks, raveled areas, etc., in old pavements can be initially repaired with asphaltic concrete, prior to

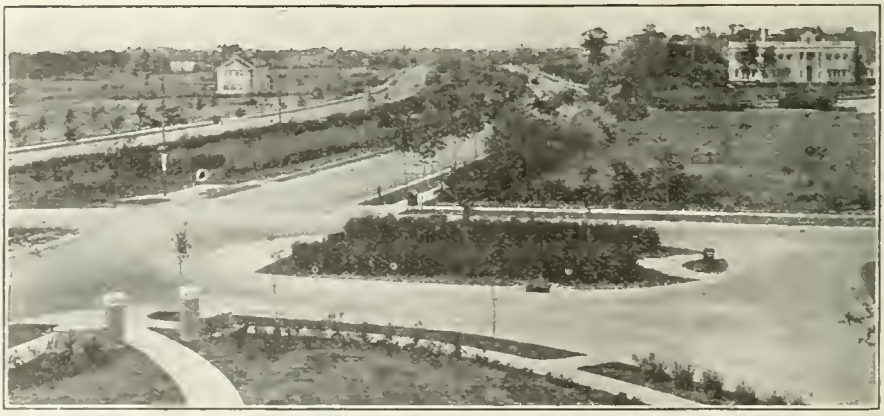
SHEET ASPHALT PAVEMENT ON NORTH FIFTH STREET, READING, PA.

applying the uniform wearing surface layer.

Just a word about foundation surfaces under asphalt pavements. Contrary to the practice of surfacing the foundation under all unit pavement construction, such as brick or block, we advocate a rough concrete surface under asphalt pavements, this because of the "keying" effect of such surface on the superimposed asphalt mixture. The roughness of such surface should be obtained by projections of part of the coarse aggregate in the concrete and not by any attempt at roughening the surface of the green concrete by the use of lug-tampers or other similar devices. Any small impressions in the concrete will be filled in the brooming of the surface prior to laying the asphaltic concrete and hence will prove valueless in anchoring such wearing surface.

Type III—Sheet Asphalt

Sheet asphalt, the standard asphalt pavement, represents the higher type of asphalt construction. Under all kinds of traffic and climatic conditions it has demonstrated by long years of service that it is one of the most satisfactory pavements ever developed. Intrinsic merit alone has permitted this type of construction to live and increase in popularity from year to year. As usually constructed this type of pavement consists of an asphaltic concrete binder course of from 1 to 2 ins. in thickness over which is laid a sheet asphalt wearing surface of 1½ to 2 ins. thick. "Close" binder strongly resembles asphaltic concrete, though no attempt is made to include a filler, while the "top" or wearing surface consists of particles all passing ¼-in. screen. Sheet asphalt pavements, their composition, method of preparation, etc., are all so well known to all who have looked into the pavement question that these features need not be discussed here. There are, however, one or two points worthy of consideration.



ASPHALT MACADAM PAVEMENT ON HARD PARKWAY, KANSAS CITY, MO., AFTER FOUR YEARS' SERVICE.

Without question, properly constructed sheet asphalt pavements are heavy traffic pavements. Long service tests in some cases extending over nearly half a century must be considered as conclusive evidence of the merits of this construction. Fifth avenue in New York, surely a beautiful street, and said to carry the heaviest traffic in the world, is paved with sheet asphalt.

The country highways today are being called upon to carry traffic which in many cases approach that which is carried by city streets. Surely a material which by service tests has proven its suitability as a paving material for city streets, will be suitable for country highways. Paving statistics show in 1915, 61 per cent of all paving yardage laid in the municipalities of the United States was of the higher type of asphaltic pavement construction. Similarly in 1916, 60.7 per cent of the yardage was asphaltic, and in 1917, 64.2 per cent represented the asphalt pavement percentage. In other words, over a period of three years, more than three-fifths of the total municipal paving yardage was of the higher type of asphaltic pavement construction. In Chicago, out of a total of 132 miles of pavement constructed in 1917, 104½ miles, approximately 80 per cent was of asphaltic construction.

For heavy city traffic undoubtedly standard sheet asphalt is a most satisfactory and economical pavement. On through country highways properly constructed "Topeka Mix" asphaltic concrete is to be recommended. In building roads or pavements we build for permanence and on a properly constructed base sheet asphalt or asphaltic concrete pavements represent types most economically maintained over long periods.

There must be and are good, logical reasons why statistics, from sources which have to deal with traffic conditions much more severe than country highways will be called upon to meet, show a general use of asphalt pavements. The principal reason is that properly constructed asphalt pavements subjected to the test of every class of traffic have demonstrated their serviceability.

They are largely composed of local material, they are smooth, noiseless, sanitary and attractive in appearance, have a low tractive resistance, and are easily repaired. Their first cost is moderate, cost of permanent maintenance is low, they lessen cost of vehicular upkeep and they are durable.

DENSE ASPHALT CONCRETE PAVEMENT SPECIFICATIONS

By J. W. Howard, C. E., E. M., Consulting Engineer on Construction and Testing of Roads and Pavements, 1 Broadway, New York; Laboratory at 234 Mt. Prospect Ave., Newark, N. J.

Municipal and County Engineering has honored me with a request to prepare a contribution which may be of practical use to cities, counties and states. The following specifications for a dense asphalt concrete pavement or road, set forth in detail what the writer believes to be the best requirements for materials and construction of this type. They are based on experience of many years, and when strictly enforced, a very durable pavement of this kind is obtained; one which is closer, denser, more water-proof and more durable than the necessarily porous and unstable ones having the Topeka and similar mixtures.

General Requirements

(1) The stone used in the binder and pavement surface layer shall be hard, tough, clean, well shaped crushed trap rock or equally good granitoid rock, silicious limestone (or hard flintic gravel) acceptable to the engineer. All stone (or gravel) must be clean, free from soft particles, clay, dust and foreign matter.

(2) The sand used in the binder and surface layer shall be clean, hard grained, moderately sharp and free from clay.

(3) The powdered mineral filler of the mineral aggregate of the asphalt concrete pavement mixture shall be powdered limestone or other suitable mineral. Seventy (70) per cent of the filler shall pass a 200-mesh sieve.

(4) The asphalt cement for the binder and surface layer of the pavement, shall have the following qualities and meet the following tests which are made by standard methods of the A. S. M. I. and A. S. T. M. and as stated below. (a) It must contain no water, coal or gas tar product. (b) It must be homogeneous and uniform. (c) It must not be injured by water or contain matter which prevents it being waterproof. (d) It must be ductile at 77 deg. Fahr. so as to be stretched at least 40 centimeters. (e) Its specific gravity at 77 deg. Fahr. must be at least (1) one. (f) Its penetration or degree of softness at 77 deg. Fahr. must be between 35 (0.35 cm.) and 50 (0.50 cm.) according to the temperature of the local climate, also the weight of the traffic, low for heavy and higher penetration for light traffic. (g) Its freedom from

volatile oils and safety for heating for use, must be tested by the open flash test; made with the asphalt cement in an open container about 3 ins. in diameter and about 2½ ins. deep, with the thermometer bulb in the melted asphalt-cement. The flash point must not be below 400 deg. F. (h) Its stability against injury by heat in use and by weather action on the pavement is determined by exposing 50 grams in an open tin can 2¼ ins. diameter, 1½ ins. deep, 5 hours, in hot oven air, at 325 deg. F., and must not lose more than 3 per cent of its original weight. (i) The penetration or degree of softness of the residue at 77 deg. F., after test (h) must be at least 60 per cent of its original penetration test (f); that is, test (h) must not harden it more than 40 per cent. (j) The purity or pure bitumen content of the asphalt-cement used in any one pavement, determined by solubility in carbon bisulphide, must not vary more than ½ of 1 per cent up or down. (k) At least 99 per cent of the pure bitumen of the asphalt-cement must be soluble in carbon tetrachloride at about 77 deg. F. (l) The asphalt-cement must have an average cementing strength (three tests) of at least 25 lbs. per sq. in. (Howard or like method), when made into a hot and fully compressed briquette composed of standard Ottawa sand (20-30 mesh size grains), 90 parts by weight and 10 parts of the approximately pure bitumen of the asphalt-cement (or asphalt-cement itself when above 99 per cent pure bitumen). These briquettes have the same shape and size as the standard Portland cement briquettes of the Am. Soc. C. E. and must be broken by tension at 77 deg. F. in any briquette cement-testing apparatus used for Portland cement tensile tests.

(5) The measuring of the proportions of the various materials specified for use in binder, and the pavement surface layer mixtures, must be done by weight for each box or batch, and the pavement mixing plant must be equipped with a permanent visible weighing device attached to the asphalt-cement measuring bucket, also a separate weighing device attached to the mineral aggregate measuring box.

(6) Vertical contact surfaces of gutters, curbs, manholes, etc., shall be well painted with asphalt-cement before the binder and wearing surface are laid. The binder and pavement next to all curbs, crosswalks, basin heads and the like shall be firmly rammed with hot rammers.

Dense Asphalt Concrete Pavement Preparation and Laying

(7) The asphalt-concrete pavement shall consist of an asphalt binder layer, laid on the finished foundation of the kind specified, and a dense asphalt-concrete wearing surface layer on the binder with a seal coat on its surface. The thicknesses of these finished two layers shall be: binder one (1) inch thick at all points, and asphalt-concrete surface layer one and one-half (1½) inches thick at all points. A slight excess of thickness of binder and surface layer is required and permitted to even up slight inequalities, if any, on the foundation or the binder layer.

(8) *Binder Layer.* The binder shall be composed of crushed stone (or gravel), sand and asphalt-cement.

(9) Preparation and laying of the binder shall be as follows: It shall be composed of crushed stone (or gravel), sand to fill the voids in the stone and enough asphalt-cement thoroughly to coat the mineral aggregate without an excess of the cement when thoroughly compressed. It shall be a firm, dense, close, binder. The analysis of the binder composition shall be as follows (by weight):

Bitumen soluble in carbon bisulphide, 4 to 7 per cent; passing No. 10 sieve, 15 to 30 per cent; passing No. ½-in. sieve retained on No. 10, 20 to 50 per cent; passing No. ¾-in. sieve retained on No. ½, 15 to 65 per cent.

(10) The stone (or gravel) sand and the asphalt-cement, heated separately to a temperature of 225 to 325 deg. F., shall be thoroughly mixed by machinery so as to produce a homogenous mixture in which all particles of the mineral aggregate are thoroughly coated with the asphalt cement.

(11) The binder shall be brought to the work in vehicles suitably covered, and delivered upon the roadway at 225 to 325 deg. F.

The temperature of the binder within these limits shall be regulated according to the temperature of the atmosphere and the working of the binder. The binder shall be dumped upon the foundation back of where it is to be laid, deposited in place with hot shovels, then uniformly spread with hot iron rakes and at once thoroughly compacted by a roller weighing at least seven (7) tons and by tamping in places that cannot be properly compacted by rolling. The surface of the completed binder course shall be parallel with and one and one-half (1½) inches

below the finished grade and crown for the pavement. Any binder which shows an excess of asphalt-cement after compression, lack of bond, or is in any way defective or becomes broken up before being covered with the wearing surface, shall be taken up and replaced with new good binder. The finished binder shall be kept clean and free from traffic, and if necessary it shall be thoroughly cleaned by sweeping just before the wearing course is laid. No binder shall be laid when in the opinion of the Engineer the weather conditions are unsuitable, and only when the foundation is clean, free from frost, hard and dry. The surface of the roller can be only slightly moistened without excess of water while rolling the binder.

(12) *Dense Asphalt Concrete Surface Layer.* The asphalt concrete wearing surface layer shall be composed of crushed stone (or gravel), sand, powdered mineral filler and asphalt-cement, all of the kinds and quallties specified for stone, gravel, sand, filler and asphalt cement. The asphalt-concrete pavement composition shall be made by first thoroughly mixing the pre-heated crushed stone (or gravel) and sand with the limestone powder (not pre-heated) in a suitable mechanical apparatus, and then adding the hot liquified asphalt-cement, so the result will be a uniform, homogeneous mixture, which by analysis and tests will be within the following limits (by weight):

Bitumen extracted with carbon-bisulphide.....8% to 10%
Mineral passing 200-mesh sieve including 200 and finer mineral.....7% to 10%
Mineral passing 80-mesh sieve and retained on 200-mesh sieve...10% to 16%
Mineral passing 40-mesh sieve and retained on 80-mesh sieve....15% to 25%
Mineral passing 10-mesh sieve and retained on 40-mesh sieve.....8% to 23%
Mineral passing 4-mesh sieve and retained on 10-mesh sieve.....11% to 22%
Mineral passing 2-mesh sieve and retained on 4-mesh sieve.....8% to 18%

(13) The combined one-fourth (¼) and one-half (½) inch mesh mineral must be at least 25 per cent, and at least seven (7) per cent of the mixture shall pass 200-mesh sieve, and the proportions of the ingredients used must give the densest compressed mineral aggregate (exclusive of bitumen) with lowest voids possible substantially within the limits of the above percentages by analysis, and such as will make the completed pavement composition compressible to a density (specific gravity) of at least 80 per cent of the specific gravity of the stone itself used in its aggregate. The per cent of bitumen shall be strictly within the limits above specified and sufficient thoroughly to coat all the particles of the mineral aggregate and produce a pavement not too soft in summer or brittle in winter; the intent being a close, dense, waterproof pavement. The fully compressed asphalt-concrete pavement must have a density or specific gravity of at least about 2.30.

(14) The asphalt-concrete must be protected and transported to the street while hot and be at least 250 deg. F. when unloaded, just previous to spreading it. Each load must be dumped clear of the area upon which it is to be laid, and preferably on a sheet steel plate. The surface of the binder must be clean, firm, solid and dry when the asphalt-concrete is placed upon it with hot shovels and spread with hot rakes, to such a thickness that after it is fully compressed with a mechanical roller of at least ten (10) tons, the finished surface shall have a thickness at least one and one-half (1½) inches at all points; a slight excess being permitted to even up slight inequalities in the surface of the binder. The compression shall be attained by first smoothing the surface with a roller, and the rolling continued without interruption until thoroughly compacted and it conforms to the required grade and crown. Pavement next to curbs, headers, manhole, etc., frames must be rammed solid before rolling. All parts of the pavement inaccessible to the roller must be thoroughly compacted with heavy iron rammers. No asphalt concrete surface shall be laid when the weather conditions are unsuitable, nor unless the binder is clean, free from frost, hard and dry. Use of water on the roller on the surface of the pavement shall not be permitted; but the surface of the roller can be wiped with a little suitable oil or mixture of kerosene oil and water while rolling the pavement surface to prevent adhesion to the pavement.

(15) *Seal Coat.* Immediately after the completion of the rolling of the asphaltic concrete, a seal coat of asphalt-cement, liquified at a temperature of 300 to 350 deg. F. shall be spread upon its entire surface and evenly distributed with squeegees. Only a sufficient quantity to coat the surface and fill the surface voids without leaving an excess shall be used. This seal coat shall be immediately entirely covered with crushed rock screenings, or clean, coarse flintic sand, not ex-

ceeding one-quarter (¼) inch size and free from dust, which shall be evenly spread and thoroughly rolled with the above roller, and the quantity used shall be sufficient to leave a small surplus of screenings or sand to be worn away by traffic and weather.

(Note.—Somewhat better pavement generally results with crushed stone than with gravel in the pavement composition. Therefore, the engineer using these specifications, will strike out the words ("or gravel") in paragraphs 1, 8, 9, 10, 12, unless local conditions require or permit the use of suitable and approved gravel.)

REVISED SPECIFICATIONS FOR BRICK PAVING

Specifications of the National Paving Brick Manufacturers' Association for vitrified brick pavements on streets and highways are now undergoing revision preparatory to early publication. The revision comes as the result of recognized trends in modern engineering practice, and was determined upon by members of the National association in their annual meeting held Dec. 6 and 7, 1921, in Pittsburgh.

The revision will consist of expanding the present specifications and rearranging several sections so as to make the grouping more systematic. The revised specifications will include all that is included in the present volume with the addition of two new provisions, as follows:

1. Recognition and acceptance as standards of the 11 sizes and varieties of vitrified brick mutually agreed upon as standards by engineers and manufacturers in joint conference with Herbert Hoover, Secretary of the United States Department of Commerce, and officials representing other government departments, as described in the December, 1921, issue of Municipal and County Engineering.

2. Addition of a department calling attention to the particular adaptability of vitrified paving brick in the construction of sewer inverts, the smaller highway bridges and for other construction.

Ratification of the action of the Washington joint conference held Nov. 15, wherein 55 out of 66 sizes and varieties of vitrified brick were eliminated as unnecessary and contributing to waste, leaving 11 as standards, was unanimous on the part of the manufacturers. E. W. McCullough, manager of the Fabricated Production Department of the United States Chamber of Commerce, who is actively cooperating in Mr. Hoover's campaign to effect sane standardization and to eliminate waste in industry, addressed the brick manufacturers discussing the results of the Washington joint conference. Not only did the manufacturers ratify the action of the Washington joint conference, but they also adopted a resolution pledging their co-operation in assisting the permanent committee of ten, decided upon at Washington and to be composed of representatives of various national engineering societies, to bring about further eliminations as rapidly as conditions warrant and in proper manner.

Manufacturers reported that because of changes already apparent in specifications, showing that engineers the country over are adopting the standards set by the Department of Commerce, their production is rapidly being limited to the 11 sizes and varieties.

Actuated by recognition of the trend in brick pavement construction toward flexible wearing-surface the national association unanimously adopted a resolution announcing its preference for the general use of asphalt filler as follows:

Whereas, The National Paving Brick Manufacturers' Association through its contact with the requirements of the paving market, maintained through the members and field engineers of its Territorial Associations, is increasingly conscious of the trend in engineering design and construction toward asphalt filler, and

Whereas, Recent investigation discloses that approximately 60 per cent of all brick pavements laid in 1921 were so filled, and

Whereas, The Association interprets this increased proportion of asphalt-filled brick pavements as indication that the majority of engineers and public officials, using vitrified brick for paving, believe that the use of such filler, under specifications providing quality and method of using according or equal to those of the National Paving Brick Manufacturers' Association, is calculated generally to insure the construction of brick pavements equal in endurance and economy to the endurance and economy inherent to the individual brick as manufactured, and

Whereas, It is the traditional policy of this Association publicly to declare its judgment, from time to time, in respect to purposes which it regards as encouraging the wisest use of public funds for paving purposes.

Therefore, Be It Resolved, That the Na-

State Trunk Line No. 13 in Kilbourn, Wisconsin. Maintained with annual treatments of "Tarvia-B" since 1916

Good Roads that Grow Better—

MOST people are satisfied when the roads stay "as good as new." But not so the Road and Bridge Committee of Columbia County, Wisconsin.

They build good roads to start with and then, by far-sighted but inexpensive maintenance with "Tarvia-B," make those good roads better every year.

This extract from their letter will be of interest to all highway officials:

"Our experience in successfully maintaining our macadam roads with "Tarvia-B" is due not only to the excellence of your product, but also the rule we follow in Columbia County of surface treating macadam roads in good condition and giving them additional treatments of Tarvia annually.

"During the past couple of years, we have used clean limestone screenings ¾" size as a covering after applying the Tarvia. We believe we are adding just a little more Tarvia surface each year than the traffic wears off, as we have several macadam roads in this county that have been annually treated with "Tarvia-B" for the past six years and are in better condition at the present time than they were when first treated with Tarvia."

The use of Tarvia re-enforces the road surface and makes it waterproof, frostproof, mudless, dustless and automobile-proof. A road maintained with Tarvia pays for itself over and over again.

Tarvia is a coal tar preparation, made in a number of grades to meet construction, maintenance and repair problems.

Illustrated booklet describing the various Tarvia treatments free on request.

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Visit our booth at the Coliseum, Chicago, Ill., during the Good Roads Show of the A. R. B. A., *January 16-20, 1922.*

New York, Detroit, Salt Lake City, Johnstown, Elizabeth; Chicago, New Orleans, Seattle, Lebanon, Buffalo; Philadelphia, Birmingham, Pueblo, Youngstown, Baltimore; Boston, Kansas City, Atlanta, Toledo, Omaha

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tional Paving Brick Manufacturers' Association, assembled in annual conference in Pittsburgh, Pa., on Dec. 7, 1921, hereby expresses its confidence in asphalt-filled brick wearing surfaces for street and highway paving properly designed and built with acceptable materials and thorough methods. And that this Association hereby declares its preference for the asphalt-filled types of wearing surface.

Provided: Preferment of the foregoing type of brick wearing surface for general use shall be without prejudice to any other type which may possess peculiar adaptation to special local conditions.

Sewer Inverts and Small Highway Bridges

Extension of the Association's specifications to include information on the adaptability of vitrified brick for construction of sewer inverts and the smaller highway bridges was decided upon following a report by Will P. Blair, Vice-President of the Association. Attention was called to the fact that vitrified brick were proof against all acids common to the sewage flow, that their use would promote economy in sewer construction and that engineers frequently request information concerning this use of paving brick. As for the use of vitrified brick for the construction of the smaller highway bridges, Mr. Blair submitted evidence of highway and railroad bridges of paving brick located in various parts of the country which have been in service for more than 20 years and still are in excellent condition.

The annual meeting was presided over by O. W. Renkert, President of the Association and Vice-President and General Manager of the Metropolitan Paving Brick Company, of Canton, Ohio. In his address the President said that the outlook for the industry was increasingly bright and that by continuing to work hard and give honest value and service, members would find the year 1922 an exceedingly busy one. He pointed out the need for cutting production costs by scientific research into methods of manufacture.

Maurice B. Greenough, Executive Secretary of the Association, outlined a well-rounded program for association work in 1922, devoting attention on the one hand to extending educational facilities, and on the other to promoting increased economy in the manufacture of brick. It was his opinion that the year 1922 would see increased activity in the industry over the year 1921, probably as much as 40 per cent.

A. V. Bleininger, Homer-Laughlin Pottery Co., and chairman of the Technical Committee of the Joint Clay Products Research Committee, discussed the work of the committee and its relation to the paving brick industry. Thus far the research work had centered around kiln firing, the speaker said. He declared the investigators already were in a fair way to decrease coal consumption in burning brick.

CREOSOTED TIMBER FOR HIGHWAY BRIDGE CONSTRUCTION APPROVED

Realizing the economic importance of the use of well-treated timber for construction purposes, the U. S. Bureau of Public Roads recently instructed its engineers to use timber creosoted by the vacuum and pressure methods where justified on economic grounds. The instructions issued in January, 1921, practically prohibited the use of timber for highway construction purposes and were generally considered by state, county, city, and other engineers to mean that the federal government disapproved of the use of well-creosoted timber. The recent instructions state that the Bureau of Public Roads will not question the use of creosoted material where the following conditions are observed:

(a) Timber trestles or bridges constructed of creosoted material treated by the vacuum and pressure method.

(b) Timber floors constructed of creosoted planking treated by the vacuum and pressure method, laid laterally with a plain or tank treated wearing floor ("half-sole"); or laid laterally or longitudinally on edge, spiked together, and covered with a mastic wearing course.

(c) Timber floors, for light traffic where single floors are laid and not protected by any covering, constructed of tank-treated material or plain material depending on whether plain timber is more likely to rot out or wear out.

For permanence at low cost well-creosoted timber for construction purposes cannot be questioned. Its use for highway construction includes piling, bridge timbers, cribbing, posts, culverts, and other miscellaneous uses, and the saving made possible by utilizing this class of material makes additional funds available for building and maintenance purposes.

WATER WORKS SECTION

SAVING $52 PER DAY ON SMALL WATER MAIN RECLAMATION JOB

By the use of equipment on a job so small that ordinarily the contractor would employ only hand labor, Q. J. Winsor, of Elyria, Ohio, saved $52 a day on a small water main reclamation job, says the Bulletin of the Associated General Contractors.

Mr. Winsor describes the job and his method of handling it in the following words:

A saving of $52 a day was made on a small water-main reclamation job, because the superintendent found available a small crane and put it to work, instead of digging the pipe out by hand.

About 300 ft. of cast iron pipe, that had been in the ground 15 years, had been cut out of the present water supply system and the city thought it was worth salvaging. This pipe lay under an old water-bound macadam road at a depth of about 6 ft. in soil that had become about the hardest kind of hard clay.

As the city had no excavating equipment of its own and the job was very small, the usual thing would have been to dig it out with pick and shovel. In this case the superintendent happened to hear of a light crane that could be hauled quickly to the job behind a motor truck, and decided to try it out.

The crane had wide steel traction wheels and was towed the two miles to the job behind a 3-ton truck, the trip taking about 45 minutes.

The equipment was a half-yard excavating bucket, reaved to get the greatest closing power and equipped with teeth. The bucket had to dig through about 8 ins. of macadam before it struck the hard clay. No trouble was experienced in doing this and fair loads of clay were taken out each trip. The trench was made just the width of the bucket, and after it got down about 6 ft. digging became a little slower, as the buckt did not dig sufficient side clearance to allow it to drop readily.

Care had to be taken as the bucket approached the pipe so as not to break it, but this did not slow up the work much. No pipes were broken and the bucket cleaned out clear to them, so that all the shovel work necessary was to dig out the joints.

The trench was dug 3 ft. wide and from 6 to 7 ft. deep. The total time taken was a day and a half, though two days were counted to allow for getting the crane to and from the job.

The superintendent said of this job that, at the rtae his men were working on other and previous jobs, the crane took the place of about 16 men. He was paying a regular rate of 50 cts. an hour; so figured on a 9-hour day basis, without the crane the job would have cost $144. With the crane costing $20 a day including operator and fuel, the cost was $40, which deducted from $144 leaves a net saving of $104, or $52 a day.

It is very probable that similar savings may be made on many small jobs.

HOW THE ELECTRIC RATE IN SPRINGFIELD, ILL., WAS REDUCED FROM 13c to 6c

By Willis J. Spaulding, Commissioner of Public Property, Springfield, Ill.

In 1894, as a protest against the high electric rates then prevailing for both street lighting and commercial use, 60 citizens pledged their credit for $1,000 each, to build an electric plant. A corporation was organized, known as the Capitol Electric Company, which at once entered into a contract with the city to erect and operate an electric utility within the city, to be conveyed to the city whenever the net earnings had met investment cost with interest. The plant paid for itself during the first five years of operation, and was deeded to the city without encumbrance. The total investment to date of transfer was $84,569.44, and the property transferred embraced what was then a modern plant and a distribution system. During these five years the Capitol Company had done a commercial business in addition to lighting the public streets.

At that period cities in Illinois had not yet been granted power to carry on commercial electric utilities, and largely for

this reason the transfer of title to the city was immediately followed by a transfer back to the Capitol Company of such of the power station equipment as was actually devoted to commercial business, and the execution of a lease contract whereby the city leased the street lighting portion of the utility to the Capitol Company for the ensuing 5-year period, expiring June 18, 1905. During the 5-year period the lease was sold to the present owners.

At the expiration of the lease in 1905, the city was met by a refusal to surrender the leased property. Injunction proceedings were begun by both sides in an endeavor to secure or retain possession, each claiming the other to be in its debt to a considerable amount under the terms of the lease. The matter was finally disposed of in 1906 by the city taking forcible possession of the property through its Police Department. Since this time the city has been in full possession.

No commercial business was taken on by the city until the fall of 1915, 2 years after the passage of the Municipal Ownership Act granting to cities the right to operate commercial utilities, a right theretofore withheld except as to water.

In 1909 I was placed in charge of the Water Works, which was already municipally-owned; and in 1911 the Electric Plant was placed in my department also. The pumping station is located on the Sangamon River, 4½ miles from the center of the city, and 4 miles from the Electric Power Station, at which location there was no condensing water available. It was self-evident that these two utilities could be operated together under one roof much more economically than as separate plants. It was also self-evident that if the city was to operate an electric power plant for street lighting, it could, with comparatively small additional expense, provide light and power for general commercial use. Of course, this is true in the case of most any city which is doing its own street lighting. There is, perhaps, no business in which the cost of production falls so rapidly with the increase in output; for instance, our cost of production per kilowatt hour since we have entered the commercial field is about one-third what it was when doing street lighting only. The city which operates an electric plant for street lighting only, is inconsistent from the standpoint of economy; for if the city can afford to produce a comparatively small output for street lighting, it can much better afford to take on commercial business, which in these days means large blocks of day power, which will tend to level up the load for a full 24-hour day and give the city the great advantage of using its investment and its employees' full time instead of only part time.

In 1913, an ordinance for the purchase of new electric equipment for the purpose of combining the Water and Light Plants was introduced in the City Council. It was the avowed purpose of the city to enter the commercial field, which at once started a vigorous fight on us by the private utility corporation which occupied the field. The City Council divided on the ordinance and defeated it 3 to 2.

Under that provision of the Commission Form Act permitting the initiative and referendum, the ordinance was then initiated by petition and passed by popular vote at a special election held in January, 1914. In the campaign preceding this election the subject of municipal operation of a commercial electric utility was thoroughly debated by opposing members of the City Council and by the public. The newspapers divided on the question and gave the matter wide publicity. Nearly all public schools of the city contain auditoriums with seating capacity for several hundred people, and meetings were held in these auditoriums and other public places attended by large crowds, and very keen and general interest was aroused.

After the adoption of the ordinance, a contract was entered into for the new equipment; but the private company brought pressure to bear on the manufacturers and persuaded them to attempt to evade delivery, which resulted in about a year's delay.

The city has installed three additional generating units since, every purchase being attached in the courts by one or more petitions for injunction. Some 20 suits were filed in all. These suits were, for the most part, directed against the Municipal Ownership Act of 1913. This Act has been upheld by several decisions of the Supreme Court of the state, and may now be considered as settled law.

One of the most important issues raised was recently decided by the United States Supreme Court. In this suit it was sought to compel all municipally-owned utilities to be placed under the jurisdiction of the State Utilities Commission. This would mean that no city could establish a municipal utility without first securing from the State Utilities Commission a certificate of convenience and necessity; which would, no doubt, be denied upon the theory that a public utility should be operated as a

monopoly, and if the field is already occupied by a private concern, such concern should be protected. The attorneys for the company argued that to compel a private utility to submit to control of a state commission, and to exclude cities from such control, was a discrimination against consumers, and therefore in violation of the Constitution of the State and of the Constitution of the United States. We contended that municipally-owned utilities were subject to regulation by the City Council, and that the State Legislature had a right and might properly provide for the regulation of the rates and rules of city-owned utilities by a different method from that used in the regulation of privately-owned utilities; and that such difference does not constitute discrimination. The company argued that under municipal ownership the poor consumer had no protection. The remark made by Justice Holmes of the Supreme Court is significant as showing the real purpose of the suit. The Judge says: "What the plaintiff (company) complains of is not extortion, but on the contrary, charging such rates as draw the plaintiff's customers away." This has been a moot question ever since regulation by state commissions began, and the decision will be of vital interest to cities owning utilities, anywhere in the United States. It protects the principle of Home Rule, which is so essential to the upbuilding and the progress of Municipal Government.

In 1916, the company raised another interesting question. It charged that the city was selling electric current at less than cost, in violation of the statute which provides that municipally-owned utilities must charge such rates as will make them self-supporting. Armed with a court order, the company employed auditors from outside the state and took possession of all our books of account. After a searching investigation, these auditors slipped out of town without making public their finding. As a matter of fact, the City Plant was earning a generous profit notwithstanding the rates were nearly 50 per cent less than company rates.

The Municipal Electric Plant began in a very small way, but has grown rapidly. Four generating units were contracted for during a period of about 6 years, every one of which involved a legal battle and a special election. The sentiment in favor of public ownership has steadily increased. This was especially shown in a recent bond election.

Because of the great difference in rates, many citizens were skeptical in the beginning, and thought it could not be possible that the City Plant was self-supporting while selling current at such low rates; but as time went on and the report of the Certified Public Accountants who audited our books at the end of each fiscal year showed a constantly increasing surplus, our citizens became convinced.

Feb. 28, 1921, the end of our last fiscal year, the value of the Springfield plant was $325,947.55. Only $38,000 of this sum was received from taxes, the balance being paid from earnings or from money advanced by customers. Additions and extensions amounting to over $200,000 have been made during the past 8 months. While the city had won the important legal battles, nevertheless, the company was able to tie our hands financially, on account of the cloud put upon our bond issues while suits were pending. To meet this situation, the city required its customers to pay in advance the cost of extensions, repaying the money in service. More than $100,000 has been advanced for new construction in this way. This method of financing has been a life-saver to our enterprise, and we heartily commend it to others who are hampered financially.

On March 10th last, the company's franchise expired. At that time the City Plant had about one-third of the commercial electric business. It was agreed that the company's property should be appraised, the value fixed by a Board of Arbitration, and the city to take it over. The property included a central station heating system as well as an electric system. Pursuant to this plan, Delos F. Wilcox, of New York, was chosen as arbitrator to represent the city; Wm. J. Hagenagh, of Chicago, to represent the company; and John F. Wallace, of New York, was selected by a committee of the Chamber of Commerce as a neutral to cast the deciding vote. A very complete appraisal and exhaustive study of the property was made, E. W. Bemis, with his engineering staff, doing this work for the city. About July 1st, 2 reports were filed by the arbitrators. The majority report signed by Wallace and Hagenagh fixing the value at $2,108,212, and a minority report by Mr. Wilcox, fixing the value at only $1,000,000, or less than half the value found by the majority. The following paragraph is taken from Dr. Wilcox's report:

"I am fully advised that in case the people of Springfield, at the coming bond election, reject the award of the Board of Arbitration as fixed by the majority of

its members, the company intends to close down its plant forthwith, hoping thereby to provoke a storm of public discontent and anger which it will strive to direct against Commissioner Spaulding and his associates in the City Government in the expectation that under the whip and spur of calamity, the city may be forced to confer upon it a non-competitive franchise which will put the Municipal Lighting Plant out of commission and give to the company a 30-year lease of life for the continued occupation of the public streets of Springfield and for the exploitation of a profitable monopoly in the electrical field, with central heating service continued as an incident thereto. Notwithstanding this "fearsome" prospect as an alternative to the payment of a price, which, in my opinion, is more than twice as much as the property would be fairly worth to the city, I cannot see my way clear to sign the award of the majority or to recommend its acceptance by the electors of Springfield."

In keeping with the above forecast made by Dr. Wilcox, the company publicly announced that all light, power and heat service would be discontinued on August 15th, unless it was granted a long-time franchise which would prohibit the Municipal Plant from taking on any additional business, thus giving the company a monopoly. This would mean that all the principal industries in Springfield, including a number of coal mines, would be shut down, leaving thousands of men and women unemployed. Practically the entire business district and 400 homes in addition are supplied with central station heat, and it would have been very difficult, if not impossible, for all of these to protect themselves against approaching cold weather. However, this harsh threat only served to incense the people and stimulate opposition to the company. It was evident that the proposed exclusive franchise would be defeated by an overwhelming vote. Just 2 days before the election the company suddenly announced that it would accept a 20-year franchise extension, which would not in any way hamper the Municipal Plant.

It was under these circumstances that the question of voting bonds to purchase the company's plant upon the terms of the award of the majority was submitted. To accept the award would mean that the city was investing at least $1,000,000 more for an old- run-down and out-of-date property than a new property or the same capacity could be installed for. It would mean the water-logging of the Municipal Plant, thus burdening public ownership in Springfield with the same evil of overcapitalization for which we criticise the private corporations. As head of the Light and Power Department, I advised against the acceptance of the award, and as an alternative, urged the voting of $400,000 in bonds for the enlargement of the City Plant. The award was voted down by about 5 to 1, and the bonds for enlarging the City Plant carried by 4 to 1. The escape of the city from great loss in this arbitration was due to the thorough and conscientious appraisal work done by E. W. Bemis, who has the protection of the public ever in mind, and by the great industry and clearheadedness of Dr. Wilcox, who proved a hulwark of defense for the city.

We have since sold our bonds and are now rapidly enlarging and extending our plant. When this $400,000 is expended, we will have as large an electric plant as we would have received from the company, and our debt will be only $400,000 instead of $2,108,000. Of curse, we shall not have the old heating system; but this would have heen a liability rather than an asset.

After exhausting every other recourse to block the city, the company has at last reduced its electric rate to practically the same as the city is charging endeavoring to stem the tide of business which is going to the City Plant.

The private plant in Springfield is one of the Hodenpyle-Hardy Group of 60 or more utilities scattered over the country. Their rates in Springfield are about ½ the rates being charged in other cities where the cost of production is approximately the same. Just how the company will explain this inconsistency, we do not know. The company's new rates were announced about the middle of October and became effective on bills which were due October 31.

We have been a little uneasy as to what the effect on public sentiment would be; but so far we cannot find that there has been any change in the disposition of the citizens to stand by their own plant for which they voted bonds. We are now attaching business at the rate of 400 to 500 consumers per month, which is almost as many as the City Plant acquired in a whole year heretofore.

The present sentiment in Springfield in favor of Public Ownership is based on the demonstration which has been going on during the past 6 years. We have felt it to be one of the duties and responsibilities of the department to keep the citi-

zens informed. We have made it a rule never to over-promise, and have secured public confidence by making good what we *do* promise. Following in the footsteps of Mr. Koiner, of Pasadena, Calif., we have kept before the citizens the economic advantages of the City Plant, which accrue not only to those receiving service from the city, but to those on the company's lines as well, because of reductions in rates which the company was compelled to make. The private company has made three reductions in rates since the city entered the commercial field. Its lighting rate was formerly 13 cts. per kilowatt hour, less 10 per cent for prompt payment. Its rate now is 6 cts., the same as as city's rate. The total savings to electric users of Springfield amount to not less than $200,000 per year.

Last year our gross income was $161,-311.29; the surplus above operating expenses and fixed charges was $50,153.49. The gross income this year will be about $220,000 and the surplus $80,000. The average cost per K.W.H. delivered to customer's meter last year was 1.996 cts., or practically 2 cts. per K.W.H. This year the average cost is running about 1¾ cts. The cost includes depreciation, bond interest and principal.

The city's rates are as follows:

For Lighting—6 cts. for the first 30 K. W. H.; 3 cts. for the next 70 K. W. H.; 2¾ cts. for all over 100 K. W. H.; minimum—50 cts. per month.

For Power—1¼ cts. per K. W. H., plus a service charge.

Cooking Rate—1 8-10 cts. per K. W. H.

When the new equipment, which is already delivered, is placed in operation, the City Plant will have sufficient capacity to supply the entire needs of Springfield.

The great inventions by which the forces of Nature are harnessed and put to the service of man, are beneficial only to the degree that they are placed within reach of the common people.

The purpose of the Municipal Light and Power Plant is to bring the magic power of electricity—the greatest invention of the 20th century—within the reach of all. It is a co-operative enterprise established by the citizens of Springfield for the benefit of all. It is neither Democrat nor Republican. It has no relation to politics whatever. The 10,000 horsepower capacity of this plant is a giant slave in the service of the people waiting to do their bidding, at the cost of upkeep only.

Electricity does many big things and it also does many little things. It is an indispensable servant in the house. It will cook your food, warm your room in cold weather and operate cooling fans in hot weather; provide comfortable warming pads to be applied to the body in case of illness; sweep the floor, wash and iron the clothes, run the sewing machine, and do many other things too numerous to mention. It will furnish light and power for all purposes.

That the Municipal Electric Plant is appreciated is proven by the fact that the number of homes in Springfield receiving electric service has nearly doubled since the city began selling current.

The coal oil lamp is being put aside. Electric cooking is being substituted for gas. The city's special cooking rate makes electric cooking cheaper than gas.

Our lighting rates are nearly 50 per cent lower in Springfield than in other cities of similar size. Our power rates are so low that they beckon to manufacturers of every kind to come to Springfield and reduce their factory cost. Springfield bids fair to become the most completely electrified city in the world.

(Editor's Note:—The foregoing paper by Mr. Spaulding was presented before the convention of the Public Ownership League of America, held in Chicago on Nov. 19-21. Like any other article published in Municipal and County Engineering, this article is open for discussion by our readers. Discussion is always encouraged in the interest of equity and advancement of knowledge.)

MISCELLANEOUS PROBLEMS IN SEWER DESIGN AND MAINTENANCE

By Milton J. Ruark, Division Engineer of Sewers, Department of Public Improvements, 311 Courtland St., Baltimore, Md.

The design and the maintenance of a sewerage or drainage system are two distinct and independent functions. Usually the engineer responsible for the designing is especially trained in this particular branch of engineering; is qualified to make the necessary surveys and calculations, and can execute detailed plans and specifications to the satisfaction of the State Board of Health or other authorities. Unfortunately, however, the consulting or designing engineer seldom has the opportunity to operate and maintain the systems, which he has planned. His knowledge of maintenance problems is,

therefore, mostly obtained from others, and is not his own experience. It is, therefore, to be expected that he will not be able to anticipate all of the maintenance difficulties, some of which may be due to local conditions, and the burden of successfully operating the system must be solved by someone else who may or may not be particularly qualified or have knowledge of the principles involved in the original design. If the engineer has exercised ordinary skill, and given sufficient thought and study to the subject so that the proper and most suitable system is adopted; if designs are prepared and detailed in an accurate manner; and, furthermore, if the plans and the specifications have been followed out by the engineer in charge of the construction, it is safe to say that maintenance problems should be few, and of such a character that only minor modifications to the system will be required, and the operation cost will therefore be small.

On the other hand, maintenance problems are often numerous, difficult to correct, and involve unreasonable up-keep charges because the sewerage system has been either poorly designed, or as is more commonly the case, constructed in a haphazard manner without sufficient engineering supervision. Where the designing engineer of the system is one who is familiar with the maintenance problems, he will, of course, avoid many errors and pitfalls that he has become aware of through experience.

The Sewerage and Drainage System of Baltimore, approximately 90 per cent of which was built between the years 1906 and 1916, has now been in service about 10 years. At the time when preliminary plans were submitted and approved, there was much difference of opinion as to the best methods of design to follow. In a great majority of instances it is clear and beyond dispute that the designs of the engineers, adopted and carried out in detail, were the best ones although there are a few cases where equal or better results might have been obtained by using some other and perhaps less expensive method.

Unobstructed and Clean Sewers

One of the chief results to be obtained by the sanitary engineer is a sewerage system that will be free of obstructions, chokages and foul odors, and which can be kept in this condition by ordinary maintenance labor. The prevailing impression is that if the grades of the sewers are sufficiently steep no trouble will be experienced with deposits forming in the sewer. The problem, however, does not end with the designer. He may have provided for sufficiently high velocities, and nevertheless when the sewer is put in service obstructions will frequently occur especially if good construction work is not insisted upon.

More important than good grades is a selection of good quality pipes, and skillful pipe laying. Pipe must be smooth, straight, and in continuous alignment throughout without the irregularities and kinks which so often occur due to the interference of other underground structures. Each joint must be made as tight as practicable, and the well established principle of straight horizontal and vertical alignment between properly spaced manholes must be observed. One of the chief causes contributory to obstructed sewers is tree roots. Where skillful pipe layers are employed, and good tight joints are made, the probability of an obstructed sewer from this cause is reduced to a minimum. Roots from the common poplar tree are responsible for most of the trouble in Baltimore, and occur more frequently in the house connection than in the lateral sewer. This trouble, however, has not been experienced in storm water drains, and is probably accounted for by the fact that small drains carry little or no flow during dry weather. Even where bituminous compound joints have been used as a precaution against tree roots, they have found their way into the sanitary sewers. It is a recognized fact that poplar trees have little value as shade trees, and that the roots also cause failures of cement or brick sidewalks. For this reason an ordinance has been passed in this city prohibiting the further planting of this species of tree. The demand and market for many of the complicated mechanical sewer cleaning apparatus so widely advertised by manufacturers is due to the fact that many municipal sewerage systems in this country have been poorly designed and constructed.

Plumbing—An Essential Part of the Sewerage System

When the sanitary sewerage system of Baltimore was put in service, each building, premise, and establishment was required to be connected to the sewerage system at the expiration of 60 days after being notified by the Health Commissioner. The regulations required that the existing plumbing be made to conform

with a revised plumbing code under which all wastes of a polluted character were required to be disposed of into the sanitary system, and rainwater or other non-polluted waste into the storm water system. Rain leaders, which were permitted to be discharged upon the surface, were connected to the storm water system at the option of the property owners. These regulations were enforced in all instances even where a building was connected to a private sewer, and considerable money had to be spent in rearranging existing plumbing to conform to the new regulations. In cases where property owners failed to comply with this notice within a reasonable time, the health authorities had the power to make these connections to the city system, and the cost of the work became a lien upon the property. Where the property owner was not able financially to do this work, the city also arranged to have the work done by the owner's plumber, the owner paying the cost, with interest, in five annual installments. The rigid enforcement of the above regulation; the elimination of all cesspools and old outside running traps, which are still in use in many cities, has done much to improve sanitation in Baltimore. Notwithstanding that the reconstruction of the house plumbing and the cost of making sewer connection has involved an expenditure, according to the least conservative estimate, of $8,000,000 on the part of the property owners, it has been demonstrated that the benefit derived has justified the course taken by municipal officials. In the business districts the majority of down-spouts are connected direct to the storm water drainage system. The practice of making separate connections to the storm water system has increased, and it is a question whether it is not better to provide a separate connection in order to dispose of all water from roofs, area-ways, subsoil drainage, and water from garage floors. If this practice were followed, large quantities of rain water would be eliminated from the surface of streets; but some authorities claim that it is better to discharge water on the surface, as it tends to keep the streets in a cleaner and more sanitary condition.

Catch Basins

With the exception of a few low-lying drainage areas there are no catch basins in Baltimore, and it is not likely any will be built in the future. Most of the storm water drains are self cleaning; and the building of catch basins would therefore serve no useful purpose, but would probably become a nuisance. Catch basins are very expensive to clean out. They soon fill up with silt, and it is difficult if not impossible to prevent street sweepers from disposing of street sweepings in these inlets in order to lessen their labor. Furthermore, catch basins often retain a good deal of decomposed matter, and they cause complaints because of odors, and prevent a free circulation of air through the drainage system.

Manhole Covers

Although the design of manhole covers would seemingly play an unimportant role in sewer design, there is room for much improvement along this line. Where the separate system is used, covers for sanitary sewer and storm water drain manholes should be clearly marked with such words as "Sanitary Sewer" and "Storm Drain" so that all municipal employees can tell the kind of sewer without taking the cover off. A penalty should be imposed for removing these covers, and the amount of the fine should be marked on the sewer. Where the separate system of sewers is used, the manhole frames and covers should not be of the same size for both systems. Unless the covers are of slightly different diameters they will be interchanged and cause much confusion in maintenance work. For example, snow is likely to be dumped into sanitary manholes under the impression that it is being disposed of into the storm water drains, which practice causes much trouble.

During the early days of the Baltimore Sewerage Commission six holes, each 1 in. in diameter were provided for in the top of manhole covers for ventilation and for removing them. As the sewers get ample ventilation through the house stacks this number was reduced to two without any ill effects. Were it not for the fact that some means have to be provided to take the covers off, no holes would be put in them at all. A good deal of ground water would thus be eliminated from the sewerage system which is treated at the sewage works.

Complaints have been made because of loose manhole covers which rattle when traffic passes over them. Experience at Baltimore has shown that the best way to remedy this condition is to have all manhole frames and covers inspected at the foundry. Only those castings that fit well are selected. They are bought by the

city, and furnished to the contractors who are building sewers.

Lampholes and Stand Pipes

Although lampholes were built on the sanitary sewers of Baltimore when the system was first installed, this practice has since been discontinued. They are a source of trouble as mischievous children remove the lamphole covers with little difficulty, and drop sticks and rubbish in the sewers, which become choked. If sewers become obstructed, lampholes are of little or no value in clearing them, and it is seldom that they facilitate maintenance work in any manner whatsoever. Furthermore, even when carefully constructed the lamphole will frequently settle and break away from the lateral sewer due to unequal settlement. House connections, which are made from deep sewers by means of standpipes, are also a source of many troubles due mostly to settlement.

Garage Connections

It is unlawful in Baltimore to connect garage floor drainage to the sanitary sewers. Thus, one of the main causes for gas explosions in sanitary sewers is prevented, although explosions have caused serious accidents in many cities. There is no record of explosions in any of the Baltimore sewers. It is permissible to connect garage drainage to the storm water drains, but the plumbing regulations require that an approved trap of ample capacity be installed on the house side of the sewer connections so as to intercept any gasoline or oils that might otherwise flow into the storm water drain.

Flush Tanks and Flushing Connections

One and one-quarter inch taps from the water mains of the city were originally extended to each terminal or dead-end manhole in order to flush out the sanitary sewers as the occasion required. The practice of installing these taps has also been discontinued as it has been demonstrated that only occasional flushing is necessary, and that the connections often rust out and become leaky in a short period of time. For similar reasons the use of flush tanks has been limited to serve sewers which are laid on very flat grades, and their use even under these circumstances is questionable. Moreover, there have not been many complaints of deposits in sanitary sewers that are at or near the end of the lines.

In Baltimore four men spend all their time in making periodic inspections of all manholes. They remove from the manhole benches such things as sticks, rags, bottles and other material that might choke the sewer. Often they find that some sewers are partially obstructed, and they immediately have these obstructions removed. This work reduces the amount of money expended in clearing the sewers, and at the same time there are fewer complaints from property owners because of flooded cellars.

Sewage Pumping Stations

A gravity system of sewers should be installed whenever it is possible so as to reduce pumping to a minimum. The design of a pumping station, either large or small, requires very careful consideration and a vast amount of detail work. Extreme caution must be exercised that the proper type of mechanical and electrical equipment is selected. Ample space for units to meet future requirements must be provided, and reserve units must be installed in case of a breakdown. The average daily flow at the main pumping station in Baltimore is 25,000,000 gals. and the maximum flow has at times reached 38,000,000 gals. per day. Nevertheless, this station has been in continuous service without interruption, and the successful operation of a station of this size is assured if the equipment is first class, kept in good repair, and a competent, reliable staff of power plant operators is provided. That pumping stations of both large and small capacities can be located in congested districts without becoming objectionable to adjacent property owners, and further that sewage screenings can be disposed of by incineration within the pumping station without causing a nuisance has been clearly demonstrated by the operation of such a station in Baltimore.

Sewage Treatment

One feature of sewage treatment that has demonstrated itself is that it is practically impossible to eliminate complaints because of odors from a large plant. A sewage treatment plant of any size is bound to give off odors and the engineer who claims that he can eliminate them altogether will be disappointed when he faces actual operation conditions. Theoretically a certain method of sewage treatment may be used without producing odors, but when all weather conditions are encountered, when wide variations in sewage flow occur, and when the plant is operated by poorly trained men who are

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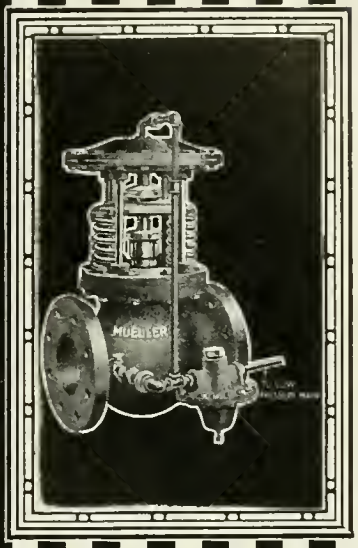
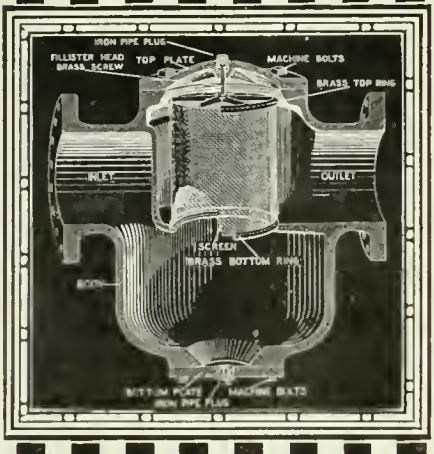
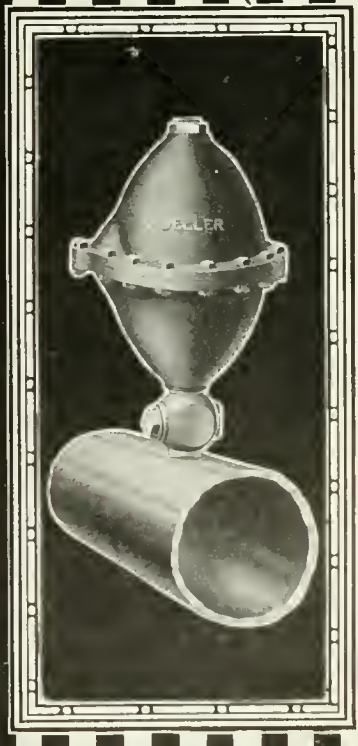






negligent, acrial nuisances almost invariably arise. Very often complaints from odors are unfounded or are exaggerated. Human psychology is such that people, who live in the vicinity of a sewage treatment plant, often imagine that they get odors from the plant when such is not the case. Where the land can be bought at a low price, it is advisable to buy a large tract as was done at Baltimore in order to isolate the plant, and reduce the number of lawsuits which are bound to follow. After the plant is built, any land bought in the vicinity of the plant can be resold with the provision that the purchasers will not enter suit against the municipality.

Conclusions

Within the past 10 or 15 years great advances have been made in sewer design. The rational method of designing storm water drains has been introduced. The separate system is becoming more firmly established. A great deal of information has been compiled as to the hydraulics of sewers, and many other valuable data have been obtained. But much remains to be done. Engineers should ascertain with a greater degree of accuracy the value and advisability of using concrete for sewers as compared to terra cotta vitrified earthenware pipe, the effect of various kinds of sewage and industrial waste flowing under different velocities and conditions both in concrete and brick lined sewers, and the life of these materials under such conditions. Engineers should as a matter of public service make a more detailed study of the storm water run-off from various kinds of pavements, etc., the percentages of water entering different types of inlets under varying surface grades and conditions. It is true that engineers have not learned the last word pertaining to the design and construction of sewers, but much ground has been covered. The most fertile field for investigation and research in sanitary science lies in the field of sewage treatment, and it is not unlikely that within a few decades our present methods of sewage treatment will give place to other methods, which are more economical and efficient.

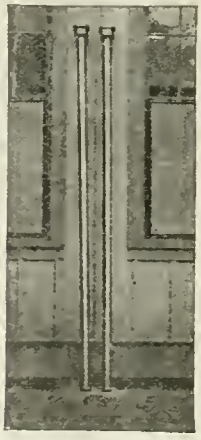
The foregoing paper by Mr. Ruark was presented at the 1921 convention of the American Society for Municipal Improvements.

CAST IRON WATER SERVICE PIPE

Although the larger sizes of cast iron pipe have long been used for services, 2-in. pipe has not been advertised for this purpose until very recently and many letters of inquiry have developed the fact that water works men were unaware of its manufacture. We believe, therefore, that this product is of sufficient interest to warrant description and discussion.

For some years there has been a gradually increasing amount of thought given to the need for a better and more durable service pipe. This need was emphasized in the "Report of the Committee on Service Pipe" of the New England Water Works Association, some years ago.

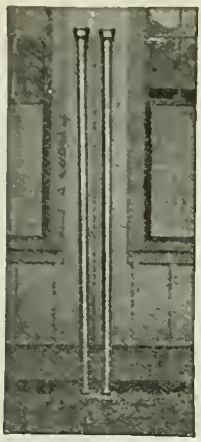
After a careful investigation, covering several years, they list the 6 important requirements for a good service pipe. In the order of their importance these are, (1) that it should not affect the water



TWO-IN. CAST IRON WATER SERVICE PIPE CAST BELL DOWN IN 9 FT. LENGTHS.

passing through it in such a manner as to make it injurious to the health of those using the water; (2) that it should not have a deleterious effect on the appearance, taste, or odor of the water even though not injurious to the health; (3) that it should have a sufficient capacity to give adequate service at all times; (4) that it should be strong and durable; (5) that it should be easily laid; (6) that it should be inexpensive.

About 10 per cent of the larger cities of the country are listed as using cast iron for at least part of their services and these cities find that it is exceptionally satisfactory. One engineer has stated that nothing will ever reduce the loss of water through leakage so much as the general adoption for service of cast iron pipe with joints that will stay permanently tight.



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Cast Iron Service Pipe

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One engineer has stated that nothing will ever reduce the loss of water through leakage in distributing systems so much as the general adoption for services of cast iron pipe with joints that will stay permanently tight. Exactly this type of pipe is offered in U. S. Cast Iron Bell and Spigot Service Pipe.

In most cities the service pipe is laid by regular water works employees who are perfectly familiar with lead-poured bell and spigot joints. So that this type of installation results in a very tight line which, at the same time, has all the flexibility of a regular bell and spigot main.

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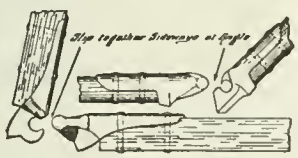

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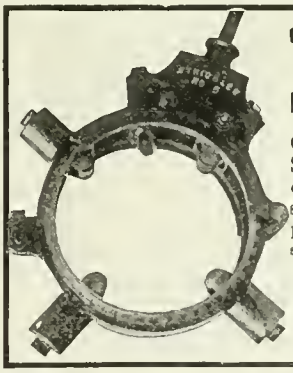

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It has been fully demonstrated that water conveyed in cast iron pipe is unchanged in quality. The minimum diameter recommended for cast iron service pipe is 2 ins. This size is amply large for ordinary needs, particularly as cast iron pipe does not fill up rapidly.

In most cities the service pipe is laid by the regular water works employees who are perfectly familiar with lead poured bell and spigot joints. This results in a very tight line which at the same time has all the flexibility of a regular bell and spigot main. Several water works superintendents have remarked the absence of leaks in this type of service.

In connection with the report mentioned above the following table was given to show the comparative life of some of the materials which have been used.

	Years Before Trouble Begins	Life of Pipe (Years)
Plain iron or steel	12	16
Galvanized	15	20
Lead	10	35
Lead lined	10	23
Cement lined	14	28

The useful life of cast iron pipe is variously estimated at from 100 to 200 years. Cast iron is by no means the most expensive service pipe and when durability is considered it is often the cheapest.

The cast iron service pipe of the United States Cast Iron Pipe and Foundry Co., here illustrated, is cast vertically with bells down so as to insure a perfect metal. The standard length for the 2-in. size is 9 ft. For service 3 ins. and over the standard bell and spigot water pipe is furnished in 12-ft. lengths.

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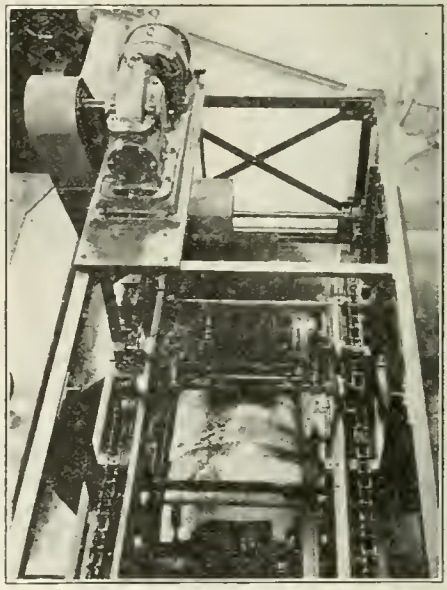
To meet an increasing demand, the engineers of the Link-Belt Company have designed a new Fine-Mesh Sewage Screen which combines great strength and rigidity with efficiency and reliability of operation.

The screen surface proper is a cylinder made either of perforated plates or the Link-Belt Straight-Wire Screen. The Straight-Wire Screen consists of bronze wires stretched tightly across a bronze frame. The clear opening between the wires is 1-32 in. or less.

The sewage enters from the outside of the cylinder, and is discharged at one end from the inside; 90 to 95 per cent of the total screening area is submersible, in other words effective. Seal rings separate the clarified from the raw sewage.

The sewage is cleaned by revolving brushes which always travel in line with the openings, never across them. This feature and the small openings made possible by the Link-Belt Straight-Wire



LINK-BELT SEWAGE SCREEN, 3 FT. DIAMETER AND 3 FT. LONG, IN SEWAGE TREATMENT PLANT AT PLEASANTVILLE, N. J., LOOKING DOWN ON LEFT HAND SCREEN FROM UPPER PLATFORM.

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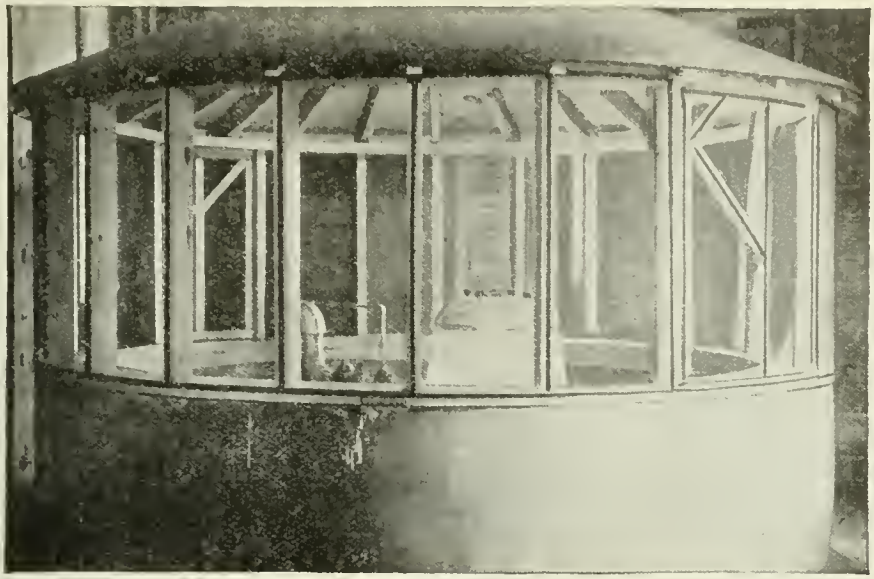
The illustration shows the left hand machine covered with the Link-Belt Straight-Wire Screen.

Engineers who have inspected the plant speak very highly of it, and even those who doubted the utility of screens for such work, are now incorporating this machine in their designs.



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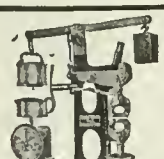

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Construction News and Equipment

METHODS AND EQUIPMENT EMPLOYED IN BUILDING CONCRETE ROADWAY ON MUSKEGON-GRAND RAPIDS, MICH., TURNPIKE

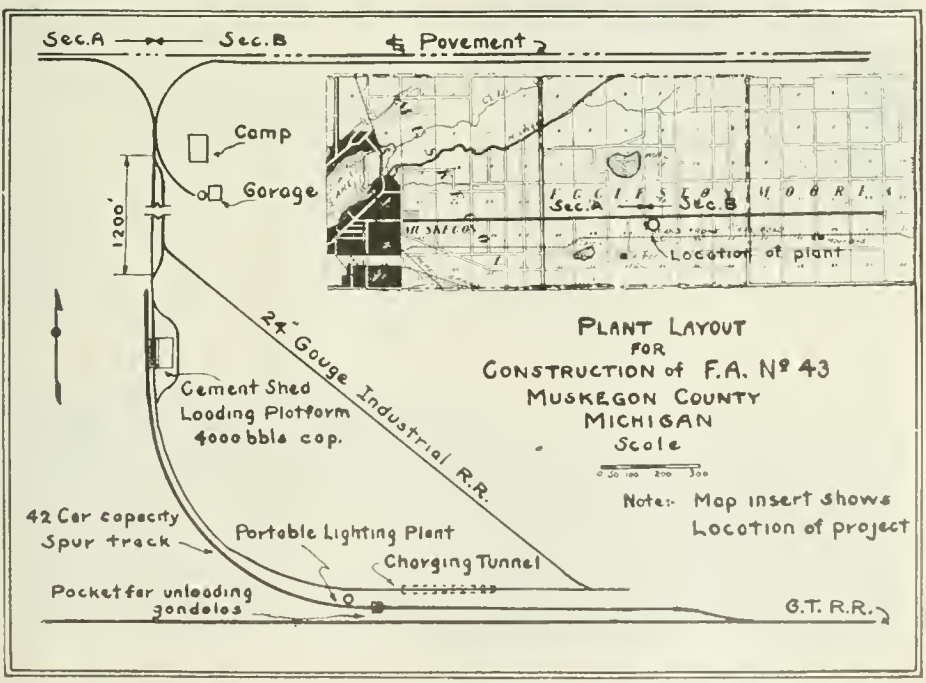
By C. E. Foster, District Engineer, Michigan State Highway Department, Grand Rapids, Mich.

Measured in miles of completed pavement, the road construction season of 1921 was a record breaker for the Michigan State Highway Department. Approximately 315 miles of hard surface road were built in sections of varying length and with nearly every type of concrete paving equipment in use, remarkable progress was made on several of the larger contracts.

One of the most interesting jobs completed in 1921 was Federal Aid Road No. 43, Sections A and B, 14 miles in length, located directly east of Muskegon on the Muskegon-Casnovia-Grand Rapids Turnpike. The contract was awarded in April, 1920, to G. P. Scharl, of Muskegon, Michigan, but due to an acute car shortage it was impossible to move sufficient gravel and sand from the Grand Rapids and Kalamazoo pits to complete the project in 1920 and only five miles of pavement were laid during the season, the remainder being completed in 1921.

The alignment of the road is practically a tangent for the entire 14 miles with a maximum grade of 2 per cent. The pavement is 18 ft. wide, 7 ins. thick at the edges and 8 ins. thick at the center with a 1-in. crown. A 1:1½:3 mix was used.

The batch box, central proportioning method was used to supply the mixer, the batches being hauled from the loading plant on a 2 ft. gauge industrial railroad. The plant was set up in the middle of the job about a half mile south of the improvement and adjacent to a 42-car capacity spur track leading off the Grand Trunk Railroad. Gravel and sand were



PLANT LAYOUT FOR CONSTRUCTION OF F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.

CONCRETING ON F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.
Left: Mixing Plant and Batch Handling Crane, Note Bottom Dump Batch Box. Right: Battery of Finishing Machines Following 2-yd. Paver.

unloaded from gondolas with a 1-yd. clamshell operated by a gasoline-driven multipedal crane. This material was stocked over a batch charging tunnel 300 ft. in length. A 1-car capacity pocket was built under the spur track to permit unloading hopper bottom gondolas, the crane handling the material from the pocket.

Forty-eight chutes in the roof of the tunnel carried the gravel and sand by gravity, to the batch boxes. The boxes were divided into three compartments and dumped from the bottom. The middle compartment carried cement and was built of sheet iron with a water-proof cover, allowing trainloads of material to be stored adjacent to the work regardless of weather conditions. Each batch contained 10 sacks of cement, 15 cu. ft. of sand and 30 cu. ft. of gravel, approximately 2 cu. yds. of loose material.

The industrial equipment consisted of 250 batch boxes on cars, one 3-ton gasoline locomotive, seven 6-ton gasoline locomotives, and 11 miles of track. Five locomotives were used on the long hauls, one used in switching and one held in reserve. The 3-ton locomotive was used spotting cars in the tunnel. The size of trains depended largely on the grades, the maximum on Section A being 42 cars, and on Section B 24 cars. Trains were delivered near the mixer and the individual cars spotted with a team of horses.

The mixer used is one of the largest in the United States for paving work, and was built along lines suggested by Mr. Scharl. The capacity of the drum is 2 cu. yds. of loose material and it is operated with a gasoline motor. The drum is charged through a stationary hopper located at the top of the machine and the batches are dumped directly into this hopper, after having been raised into position by a gasoline multipedal crane. The multipedal is connected to the mixer truck with draw chains and moves the mixer forward as the work progresses. The crane method of handling the batches is very rapid of operation, as a batch is held in readiness to charge the drum as soon as the mixer is closed after discharge. A minimum of time is required to get the material into the drum on account of the hopper arrangement which makes the charging almost instantaneous. The crane may be detached from the mixer and used in other work.

Each batch was mixed for one minute and placed with boom and bucket on the subgrade with sufficient water content to make a workable batch. The concrete was spread and finished with two finishing machines. Previous experience showed that one machine could not satisfactorily handle the volume of concrete turned out by a paver of this size. The finished concrete was covered with earth

SUBGRADING OPERATIONS ON F. A. ROAD PROJECT NO. 43, MUSKEGON COUNTY, MICHIGAN.
Left: Subgrader Built on Job; Very Simple in Construction; Does Excellent Work in Light Soils. Right: Prepared Subgrade; Fine Grading Crew in Distance.

and cured with water for 14 days. The water supply came from creeks and was pumped to the job through 2½-in. pipe lines.

Most of the rough grading was done with a heavy duty grader hauled by a 20-ton tractor. The fine grading was done with a subgrader built on the job. The shouldering was finished with a crane and clam shell and a part of the ditching was also handled with the crane converted into a drag line to which was attached a large board scraper.

Paving in 1921 started April 25th at the west end of Section B and the seven miles were completed June 13th, making an average of one mile per week for seven weeks. The best record for one day was 1,340 lin. ft. of pavement in a continuous run of 11 hours, although runs of 1,000 to 1,200 lin. ft. were not uncommon. The workmansbip both on the pavement and the shoulders is excellent. The west two miles of Section A were laid in 1921 with a smaller industrial outfit.

The work was done under the supervision of the Grand Rapids District Office of the State Highway Department and the field engineering was handled by the Muskegon County Engineer, who was employed by the State Highway Department as Resident ngineer.

DEVELOPING A LOCAL GRAVEL DEPOSIT FOR GRAVEL ROAD WORK

As a means of utilizing a gravel deposit adjacent to the job and saving the expense of hauling materials a distance of some 15 miles from the nearest commercial sand and gravel plant, the Ann Arbor Asphalt Construction Company is successfully employing a Sauerman power drag scraper system in connection with a 10-mile gravel road contract near Hamburg, Mich.

Several features are of especial interest. There are two 1 cu. yd. scrapers operated by one 35-H.P. double-drum steam hoist, which is unusual. When one scraper is discharging its load into the hopper at the gravel bin, the other scraper is at the far end of the pit digging another load.

A second uncommon feature of this Installation is that the scrapers have carried the pit down to a depth of 50 ft., whereas this type of equipment, generally speaking, is not considered adaptable to deep digging, being designed chiefly for hillside excavation, stripping overburden and so forth. The accompanying illustration gives an idea of the long, steep incline up which the scrapers have to travel due to the depth of the excavation.

The gravel is excavated, screened and loaded into motor trucks with a minimum of labor. As the scrapers are of the bottomless type, they load and dump automatically, consequently no pit-men are required. One man operates the scrapers;

SHOWING INCLINE FROM GRAVEL PIT AND SAUERMAN SCRAPER DISCHARGING ITS LOAD THROUGH TRAP ONTO GRIZZLY.

a fireman and a man to watch the screen and the loading bin complete the crew. When a scraper reaches the top of the incline, its load of raw material drops through a trap onto a grizzly that takes out the over-size stones, then passes over a screen where the excess sand is removed and then flows into the storage bin, where the motor trucks are loaded.

Mr. Manley Osgood, president and manager of the Ann Arbor Asphalt Company, who is responsible for the installation, says it is a very economical, trouble-saving method of obtaining gravel for road construction purposes.

NEW PORTABLE MIXING PLANT FOR REPAIRING, RESURFACING AND LAYING BITUMINOUS PAVEMENTS

By Monroe L. Patzig, Consulting Engineer, Patzig Laboratories, 206-210 Eleventh St., Des Moines, Iowa.

To fill the need for a small Portable Asphalt Mixing Plant, that can be used economically by contractors or others for repairing sheet asphalt, asphaltic concrete, bitulithic and similar pavements, the plant described herein has been built by the New Monarch Machine and Stamping Co., of Des Moines, Iowa.

The plant was completed about the first of November, 1921, and has since that time proven itself capable of doing all that it was designed to do.

Its general principle is similar to the larger sized standard type asphalt mixing plants. A drum is used for heating the mineral aggregate, and a standard twin pug mixer for mixing the aggregate with the asphalt.

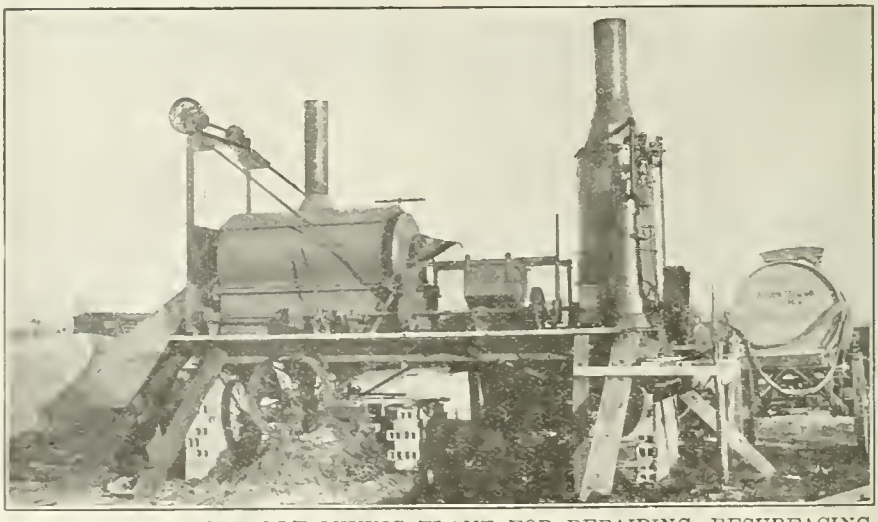
Certain features or operations of it, however, are quite different from those found in the larger types. For the purpose of eliminating excessive weight the plant was designed so the heating drum takes only one batch at a time. Mineral aggregate is taken from the various piles of different sized aggregate in the exact proportions necessary to secure the desired grading. These proportions make up a single batch which is dumped into the skip, thence hoisted and dumped into the drier drum.

The drum has an extra large grate area, the gases and heat come in contact with the lower side of the revolving drum and go up between the sides thereof and of the jacket surrounding it, to the smoke stack above. The interior of the drum is provided with spirals extending from the receiving end to within 18 ins. of the discharge end. At this end horizontal troughs are attached to the circumference of the drum and pick up the heated aggregate and drop it onto a discharge chute. A small hot sand bin receives the discharge from the drum and is then pushed along its track to a position over the mixer where it is discharged. Through the twin pug mixer the mixed material is dropped into the wagons in the usual manner. Asphalt can be dipped or pumped from the portable kettles as required.

While one batch is mixing, another batch is running through the heating drum and being delivered into the hot sand box, while a third batch is being put into the skip hoist.

A 6 cu. ft. twin pug mixer was used and batches varying between 400 and 550 lbs. were run through successfully.

A steam line from the boiler into the stack of the heating drum made it possible to regulate the heat as required very simply and easily. The time required for heating the batches of aggregate was about 3 minutes. Since the plant was designed for a 500 sq. yd. capacity of 2-in. wearing surface, and the materials were very wet and frozen at the time, it

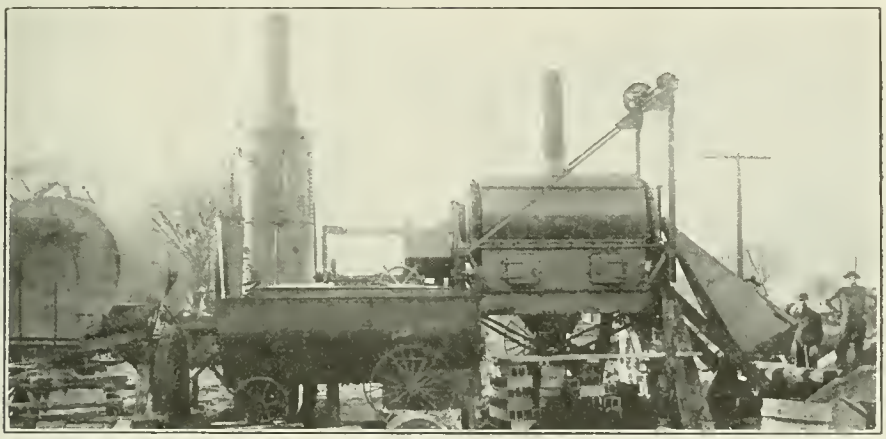


VIEW OF NEW PORTABLE MIXING PLANT FOR REPAIRING, RESURFACING AND LAYING BITUMINOUS PAVEMENTS.

was considered that the results accomplished were better than expected.

The 20 h. p. upright boiler and 15 h. p. vertical engine have also proven entirely satisfactory. Steam is also available for heating the pug mixer walls, draft for the heating drum and for agitating the kettles. A single shaft from the engine operates the mixer, heating drum and the skip hoist.

The first day's operation of this plant showed remarkable results although all men employed were inexperienced and more help was employed than was necessary.



ANOTHER VIEW OF NEW, SMALL SIZE, PORTABLE ASPHALT MIXING PLANT.

With 12 men at the plant, 2 teams hauling hot stuff, and 10 men on the street and a roller man, a 342 sq. yd. run of 2-in. asphaltic concrete for patchwork was made at a total cost for labor, materials, fuel, insurance, interest and depreciation, of 86c per sq. yd.

On the following days, more work was run out with four less laborers, thus reducing the above cost for a 500 sq. yd. run to 70c per sq. yd.

The temperatures of materials were exceptionally uniform and the analysis of the mixtures run showed perfect results.

The plant was designed by the writer with the intention of providing a plant that can successfully be used for small jobs of resurfacing or patchwork. For patchwork it will enable the contractor to furnish a mixture which is not injured by overheating or made of reheated materials mixed at some other point. The writer desired to secure a plant which would assure paving mixtures that are known to be manufactured according to specifications for original work.

The entire plant with all of the equipment required for patchwork or resurfacing work can be shipped on a single flat car and can be erected ready to run within a day after unloading.

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The Pawling & Harnischfeger Co., of Milwaukee, has standardized a line of Contractors' Stationary Hoists. They are made in types for electric, gasoline and belt drive, in sizes ranging from 8-H.P., with 8x12-in. drum, up to 115-H.P., with 18x28-in. drum. The long experience of the Pawling & Harnischfeger Co. in building its own hoist drums, electric motors, controllers and brakes used on its traveling cranes and monorail hoists has been drawn upon in the development of the stationary hoist line.

The same high quality electrical apparatus as furnished on P. & H. electric traveling cranes and hoists is used on all P. & H. electrically driven contractors' hoists.

For the gasoline-driven hoists, motors of the types that have proven successful in P. & H. Gasoline Excavator Cranes, Trench Excavators, Gas Shovels and Dragline Excavators are used. These are in all cases of the heavy duty, 4-cylinder, vertical tractor type, with Bosch Magneto, Master Carbureters, Stewart Vacuum Systems and air cleaners. Automatic throttle governers are provided and conveniently located hand throttles.

The belt-driven types are similar except that the rear end of the bed frame is left off, and a large size driving pulley is provided on the side opposite the operator. The construction for all types is similar—the bed plates and side stands are of box and I-beam section design, with heavy cross-girders and bottom and top flanging. Plates are accurately planed and side-faced. Through bolts only are used and all holes are drilled in jigs and fixtures. All drum shafts are of high-grade carbon steel, turned and ground to exact size, giving a fully polished bearing for the drum bushings and side stands. Gears are made with cut teeth, and motor pinions and gears are hobbed. Drum gears are of solid web type, with large hubs pressed in place on the shafts by hydraulic pressure against a shoulder.

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ROADS AND STREETS

Ala., Mobile—Hancock Bros. awarded contract for constructing conc. road, Mobile Co. at $148,326.

Ala., Mobile—Hancock Bros. awarded contract by State Hwy. Dept., for constr. of Craft Hwy. connecting Mobile and Chickasha, at $50,000.

Ark., Morrilton—Morena-Burkman Co., St. Louis, Mo., awarded contr. for paving streets; conc. base 6 in. thick and 2 in. asph. top; conc. gutters and curbing, at $101,000.

Ariz., Phoenix—White & Miller, 1623 W. Washington St., Phoenix, awarded contract for impvt. of 7th St. at $2.70 per yd. Work involves 21,082 sq. yds. paving; 21,028 sq. yds. grading at 33c yd., 9,963 lin. ft. comb. cem. curb and gutter at $1.50 per ft.; 918.05 ft. curb at $1 ft.; 382 lin. ft. gutter at $1 ft.; 945 lin. ft. valley gutter at $1.50 ft. and minor items includ'g conc. and vit. pipe culverts, storm water manholes, gutter inlets and sheet iron Irrigating gates.

Ca., Calexico—Lynn S. Atkinson, Chapman Bldg., Los Angeles, award. contract for grading and constructing cem. curb and walks, also cross walks on a large number of city streets at $269,495.

Cal., El Centro—H. H. Peterson, Loma Potal, San Diego, awarded contract at about $184,520 for paving with 5½-in. cem. conc. 5 sections of county hwy.

Cal., Los Angeles—California Constr. Co., San Francisco, awarded contract for paving with cem. conc. shoulders and a sph. conc. wearing surface 3.71 miles state hwy., Fresno Co.,—Selma to Kingsburg—at $37,739; Southwest Paving Co., 415 Washington Blvd., Los Angeles. awarded contract for surfacing with asph. conc., 7.04 miles state hwy. in Los Angeles Co., at $75,648.

Cal., Los Angeles—Fairchild-Gilmore-Wilton Co., Los Angeles Ry Bldg., awarded contract for paving Eagle Rock Ave. with cement conc. and constructing monolithic conc. and conc. pipe storm sewers, at $40,409.

Cal., Sacramento—Clark & Henery Constr. Co., Stockton, awarded contr. for surfacing with asph. conc. 7.85 miles state hwy. Santa Clara Co. betw. Morgan Hill and Gilroy, at $14.115; Southwest Paving Co., 415 Wash. Blvd., Los Angeles, awarded contract for paving with conc. shoulders and asph. wearing surface 8.4 miles state hwy., 2 sections Santa Barbara Co., at $92.884; Federal Constr. Co., San Francisco, awarded contract for surfacing with asph. conc. 2.3 miles in Fresno Co., at $28,493.

Cal., Sacramento—J. P. Holland, San Francisco, awarded contract for 12-mile graded section in Mendocino Co. at $170,239; Federal Constr. Co., San Francisco, awarded contr. for 2.27 mi. asph. conc. surfacing to be laid no. of Fresno, at $23,943.

Cal., Sacramento—J. P. Holland, San Francisco, awarded contract for grading 12 miles state hwy. in Mendocino County betw. Flynn Creek and mouth of Navarro River, at $170,239.

Cal., Santa Ana—Graham Bros. & Bruce, 321 E. 4th St., Long Beach, awarded contract by Co. Supvrs. at $32,112 for widening and bldg. concrete pavement on Garden Grove Ave. with concrete, at $32,112.

Cal., Santa Barbara—Fairchild-Gilmore-Wilton Co., Los Angeles Ry. Bldg., Los Angeles, awarded contract to constr. Surf-Lompoc Hwy. 29 miles in length, at $497,989; Hunter & Richardson, 525 E. Haley St., Santa Barbara, awarded contract for paving portions of Haley, Cota, Soledad and Casitas Sts. with 5-in. cement conc. base with 1½-in. asph. conc. top; comb. cem. curb and gutter, 8-in. and 6-in. vitr. pipe sewers, 76 4-in. house connection sewers, dry rubble walls, catch basins, at $55,136.

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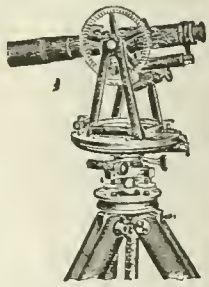

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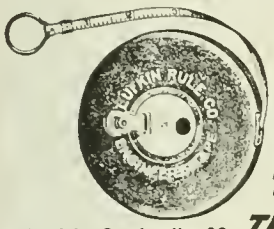

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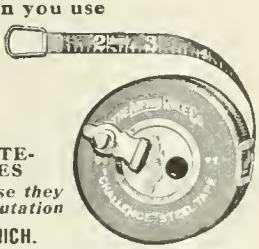

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Cal., Turlrock—A. Teichert & Son, awarded contract for paving Florence E. Olive, Myrtle, Merritt, Sycamore, Lander and First Sts., at $73,042.

Cal., Yuba City—Byrne & Most, Sacramento, awarded contract for constr. of concrete hwy. from Kirksville to Knights Landing—4½ miles, at $23,191; Chesson & Lilly, Marysville, awarded contr. to build Oswald lateral a dist. of little more than 2 miles, at $5,860.

Fla., Kissimmee—E. P. Maule awarded contract to complete Melbourne-St. Cloud-Kissimmee Rd. from Melbourne to Osceola Co. line, at $119,852.

Fla., Melbourne—Morgan Paving Co., Miami, Fla., awarded contract for 2½ miles paving, at $230,450—40 ft. and 20 ft. paving; waterbound macadam base course; bitum. penetration wearing surface or surface treatment and conc. curb.

Ia., Ames—W. W. Malkmus, Livermore, Ia., awarded contract for gravel surfacing approx. 4 miles Co. Rd. System, Humboldt Co., at 46c for gravel 1 mile haul and 6c for each unit of additional half-mile haul, 4,000 cu. yds. gravel, 1 mi. haul and 16,800 units additional half-mile haul; F. A. Engstrom, Renwick, Ia., awarded contract for graveling 2 miles Twp. Rd. Vernon Secondary Rd. Dist. No. 1; 1,600 cu. yds. gravel 1 mi. haul at 45c per cu. yd. and 1,500 units additional half-mile haul at 10c per munit; Following contracts let for road work in Winnebago Co. on Primary Rd. Proj. 120: Wm. Dutton, Boone, Ia., contract for 19,404 cu. yds. earth excav. at 32c per cu. yd., 2,312 cu. yds. earth excav. at 35c per cu. yd.; L. H. Marvill, Des Moines, 9,202 cu. yds. gravel, 1 mi. haul, at 38.7c per cu. yd., 57,720 units gravel ½-mi. haul at 10.4c per unit; 17,160 cu. yds. gravel 1 mile haul at 38c per cu. yd., 84,240 units gravel ½-mi. haul at 10c per unit.

Ia., Ames—Following contracts let by State Hwy. Dept.: C. R. Yegge, Boone, Ia., gravel surfacing roads in Dist. No. 29, Boone Co. Secondary Rd. Dist No. 29, gravel 1st mile haul at 29.9c per cu. yd. and 8c per unit for additional half-mile haul; Thos. Farrell, Jefferson, Ia., grading ½-mi. rd. in Kendrick Twp., at 37.5c per cu. yd.; grading and draining 6.84 mi. from Fairfield so. F. A. P. 120, Jefferson Co. C. L. Reis, Ottumwa, Ia., tile material and tile labor and Type "A" and "B" intakes; W. W. Cummings, Ottumwa, 81,144 cu. yds. earth excav. at 27c per cu. yd.; Scott Co. FAP 55, Sec. B. paving, draining and incidental work on Davenport-Harrison Street-New Liberty Rd.: David Wisely & Son, Sheffield, Ill., tile material; L.M. Harrison, Traer, Ia., tile labor and intakes; Scott Co., FAP 55, Sec. C, grading and draining 3.94 mi. Davenport-LeClaire Rd. from LeClaire southeast. E. D. Jenner, Davenport, Ia., earth excav. loose rock and solid rock; David Wisely & Son, Sheffield, tile material; Wm. Rathlef, Eldridge, Ia., tile labor and intakes; Scott Co. FAP 114, guard rail and baffle wall constr. on Davenport-New Liberty, Davenport-Mt. Joy and Davenport-Princeton Rds.; J. W. Ogle, Ames, guard rail constr. at 38c per lin. ft.; Pewick Constr. Co., Des Moines, baffle walls complete at $10.50 each; Scott Co., FAP 135, Sec. A, 2.947 mi. from McDonald's Crk. toward Clinton Co. line; Jas. J. Ryan, Muscatine, tile deliver; Wm. Rathlef, Eldredge, Ia., tile labor and Type B intakes.

Ia., Council Bluffs—E. A. Wickham Constr. Co., Council Bluffs, award. contract. for improving 43 miles county road. Work will start in spring.

Ia., Crowley—F. C. Barbour awarded contract for constr. of Herre relift road; gravel Sub-Rd. Dist. No. 2 plans rd. constr. 27 miles. $350,000 available.

La., New Orleans—J. D. Harvey & Co., Memphis, awarded contract for 23.8 miles Pershing Hwy., Jackson Parish, at $125,583.

Minn., Breckenridge—E. W. Coons Co., Hibbing, awarded contract for paving 7 blocks, 8th St., N. from Minn. Ave. to Bede Ave. and 5th St.—New York Ave. to Bede Ave., at $84,601.

Minn., Foley—McCree, Moos & Co., 711 Merchants Natl. Bank Bldg., St. Paul, awarded contr. for conc. paving on State Proj. 27-21, 23 miles long, at $244,811.

Minn., St. Paul—Following contracts let by State Hwy. Dept.: T. H. No. 10, Hancock-Clontarf, 9 mi. gravel surfacing, to Dobhelman & Rasmussen, Minneapolis, at $20,066; T. H. No. 28, Browns Valley eastward, 23.4 mi. gravel surfacing, to Scully & Connelly Cos., at $64,616.

Minn., St. Paul—Following contracts let for road work which includes 25 gravel-surfacing jobs totaling 260.57 miles at $467,336; 7 grading jobs on 86.10 miles with bridges and culverts included at $454,852—grand total on the 32 projects, $922,188; Geo. W. Kinney, Foley, T. H. No. 2, 6.2 mi., gravel surfacing at $8,539; G. H. Gatzenmeyer & Co., Minneapolis, T. H. 3, at $10,581; T. H. No. 5, 5 miles gravel surfacing to Morton & Bjerkness, Minneapolis, at $8,795; T. H. No. 7, 4.5 miles grading, Jack Brown, Madison Lake, grading, $14,501; Sublette and Dwyer, Minneapolis, mono-culvts,, $4,728; Elk River Conc. Products Co., Elk River, culvt. pipe, $875; T. H. Nos. 7 and 60, 11.3 mi. grav. surfacg. C. F. Scully Equipt. Co. and Connelly Constr. Co., St. Paul, $27,669; T. H. No. 8, 11.8 mi. gravel surfacing; Div. A to Northern Rd. Constr. Co., Minneapolis, at $19,897; Div. B to Floan & Sundstrom, So. Hibbing, at $7,564; T. H. No. 8, E. Grand Forks-Fisher, 15 mi. gravel surfacing to Peter Mortenson, Hibbing, at $14,246; T. H. No. 8 and 65, 15.7 mi. grading Windstron Bros., Minneapolis, $93,464; Schmitz & Mayer, Frazee, mono. culvts., $20,089; Minneapolis Bridge Co., Minneapolis, Culvt. pipe, $1,414; Gt. Northern Bridge Co., bridge, $4,500; T. H. No. 9, 5.1 mi. grading; A. Guthrie & Co., St. Paul, grading, $52,575; mono. culvts. $7,794 and 2 bridges, $12,410; Lylue Culvt. Co., Minneapolis, culvt. pipe, $446; T. H. No. 9, Jackson-Worthington, 8 mi. grav. surfacing, to G. H. Gatzenmeter & Co., Minneapolis, at $14,006; T. H. 10, 8.9 mi. gravel surfacing, to Chas. Weaver, Anoka, $11,346; T. H. 10, 12.2 mi. gravel surfacing, Chas. Weaver, Anoka, $17,867; T. H. 10, 9 miles gravel surfacing, to Dobbleman & Rasmussen, Minneapolis, at $20,066; T. H. No. 18, 4 miles gravel surfacing to Clusian & Lidberg, Grand Rapids, at $7,017; T. H. 18, 9.9 miles gravel surfacing, to Winston Bros., Minneapolis, at $16,733; T. H. No. 21, LeSueur Center to St. Henry, 11.0 miles, gravel surfacing, (2 contracts) to S. J. Peterson, Minneapolis, at $23,113; T. H. 23, 13.6 miles grading to Wilkins & Pettijohn, Park Rapids, at $33,910; Independent Bridge Co., Minneapolis, $3,790 for bridge; Gt. Northern Brdg. Co., Minneapolis, bridge, $6,500; Morris Constr. Co., Morris, mono. culverts, $9,786; Western Steel Products Co., Duluth, culvert pipe, $886; T. H. No. 23, Foley-Milaca, 15.6 miles grading; Wilkins & Pettijohn, Park Rapids, grading at $37,822. Milaca Bridge Co., Milaca, brdg., $7,390; mono-culvts., $8,918; Western Steel Products Co., Duluth, culvt. pipe, $2,156; T. H. 28, 11.8 mi. grading, Jurgenseon Constr. Co., Summit, S. D., grading, $44,186; Morris Constr. Co., Morris, mono-culvts., $13,724; Klauer Mfg. Co., Dubuque, Ia., culvt. pipe, $886; T. H. 28, Swanville-Sauk Center, 16 miles gravel surfacing, Campbell Constr. Co., Minneapolis, at $17,634, 2.9 mi. gravel surfacing, Dobbleman & Rasmussen, Minneapolis, at $2,795; Browns Valley eastward, 23.4 mi. gravel surfacing to Scully & Connelly Cos., at $64,616; 4 miles gravel surfacing, to Scully & Connelly Companies at $3,239; T. H. No. 30, Bijou-Waubun, 18 mi. gravel surfacing to Dobbleman & Rasmussen, Minneapolis, at $41,067; T. H. 34, 5.47 miles gravel surfacing, to Dobbleman & Rasmussen, Minneapolis, at $17,800. T. H. 34, 5.47 miles gravel surfacing to Wilkins & Pettijohn, Minneapolis, at $9,546; T. H. 35, 8 miles gravel surfacing, Camphell Equit. Co., Minneapolis, at $12,395; No. 35, 9.8 miles, grading, Winston Bros. Minneapolis, grading, $54,478; Roach Constr. Co., Gaylord, monoculverts, $16,743; Western Steel Products Co., Duluth, culvert pipe, $591.15; No. 35, 7.5 miles gravel surfacing to Day Bros., Minneapolis, at $14,579; No. 54, 12 miles graved surfacing to Frank Goergen, Wheaton, at $12,531; No. 68, 17 miles gravel surfacing to F. C. Mitchell & Co., Rochester, at $28,849.

Mo., Jefferson City—Following contracts let by State Hwy. Dept.: C. W. Dillingham, St. Joseph, Mo., awarded contract for constr. of 1.804 miles State Rd. east and west thru Livingston Co., at $24,722; Kerby A. Raines, Fayette, Mo., contract for constructing 4.157 miles State Rd. from Ashland to Jefferson City, at $17,196; Norman Davis, Sikeston, Mo., contr. for grading, culverts, bridges, gravel pavements, etc., on 8.976 miles State Rd. east and west of Dexter, at $59,810; R. A. Ross, Kans. City, Mo., contract for constructing 7.94 miles State road no. and so. thru La Grange Special Rd. Dist. Lewis Co., FAP 39, at $83,465.

Mo., St. Louis—Unit Constr. Co., St. Louis, awarded contract for emay Ferry Rd., at $243,981.

Contract calls for bldg. 7.3 miles 18 to 20 ft road southward from Telegraph Rd.; Whitlow Constr. Co., Charles City, Ia., contract for Gravois Rd. 6.7 miles 20 ft. rd. FAP 78, at $192,208.

Mo., Sikeston—Norman Davis, Sikeston, awarded contract for bldg. state road 8.976 miles long, east and west of this city, (Dexter), at $559,810. Work includes grading, constr. of culverts, bridges, riprap and gravel pavement 16 ft. wide.

Minn., Wadena—Campbell Constr. Co., 3050 Hennepin Ave., Minneapolis, awarded contract for approx. 16,391 sq. yds. pavement at $49,719.

Neb., Kearney—Peterson, Shirley & Gunther, 1102 W. O. W. Bldg., Omaha, for graveling Proj. 127, at $65,015.

Neb., Lexington—Peterson, Shirley & Gunther, 1102 W. O. W. Bldg., Omaha, awarded contract for grav. surf. Overton-Cozad Rd., at 37½c, or total of $47,150.

Neb., Lincoln—Shirley & Gunther, Omaha, awarded contract for graveling 30 miles Nebraska roads; 12 in Dawson and 18 in Buffalo Co., at $112,166.

Neb., Omaha—E. A. Wickham, Council Bluffs, awarded contract for impvt. of west ends of Lincoln Hwy. River-to-River Rd. Pioneer Trail and White Pole Rd., at $300,000.

N. Y., Albany—Michael H. Ripton, Rochester, awarded contract for construction of Cherry Valley-Sharon Springs-Canajoharie Rd., at $339,262; A. F. McConville, Ogdensburg, awarded contract for constr. of Grand Gorge-Breakabeen Rd., Schoharie Co., at $159,550; Schunemunk Constr Co., Highland Falls, awarded contract for constr. of Montelo-Grahamsville Rd., at $81,000.

N. Y., Au Sable Forks—Antonio Barboni, Syracuse, awarded contract to constr. Ticonderoga Rd., 8.02 miles in length, at $250,601.

N.C., Monroe—Redmon Construction Co., Monroe, awarded contract for Proj. 695 in Union Co., at $112,604—4.51 miles hard surf. Topeka pavement.

N. C., Shelby—Southern Paving Co., Chattanooga, Tenn., awarded contr. for Proj. 823, Cleveland Co., involving 1.90 miles hard surface rd. on Route 206, at $54,814.

N. C., Williamston—J. P. Dicus, Burgaw, awarded contract for Proj. 155, Martin and Pitt Counties on Route 90 from Williamston to Bethel, involving 19.31 miles of grading and surfacing, at $58,784.

N. C., Wilson—P. R. Ashby, Raleigh, awarded contract for Proj. 291, involving 7.63 miles hard surface road in Wilson Co. on Route No. 40, at $184,993.

N. C., Winston-Salem—Atlantic Bitulithic Co. awarded contract for street paving here during ensuing year which will include 150,000 to 200,000 yards.

Tex., Brenham—Walling & Haralson, Houston, awarded contract for paving, at $95,000.

Tex., Cuero—Hutto & Son, Gonzales, Tex., awarded contract to construct 10.31 miles gravel road and build conc. bridges, at $72,000.

Tex., Dallas—Texas Bitulithic Co. awarded contract for paving of Preston Rd.—Wycliff Ave. to Beverly Dr.—at approx. $190,000.

Tex., Sherman—T. J. Larkin & Sons, Dallas, awarded contract by Grayson Co. Commrs. Court for constr. of almost $500,000 worth of gravel roads in Grayson Co. Roads are to be built in following three districts in the county: Gunter, $190,000; Howe, $150,000, and Southmayd, $99,000.

Olympia, Wash—State Hwy. Comn. let following contracts: Clearg. gradg. draing. and surfacg. with crushed rock about 3.0 mi. Navy Rd. Hwy. betw. Tidewater Crk. and Charleston, Kipsap Co., to Fred Morgan, Buckley, at $79,584; Hans Pederson, Seattle, contr. for similar wk. but surfacing with gravel, aht. 3.1 mi. North Bank Hwy. Skamania Co., at $54,538; Voyle & Lindsay, Stevenson, awarded contract for surfacing with gravel about 1.0 miles No. Bank Hwy. from Stevenson west in Skamania Co. Posy Rd. Proj. 86, at $3,837; Pincella & Velero, Naselle, contr. for clearg. gradg. and draing, abt. 2.0 miles Ocean Beach Hwy. bet. Nasel and Johnson's Landing, Pacific Co., at $26,138; Relnseth & Co., Everett, contr. for similar work and surfacing with gravel aht. 9 miles Olympia Hwy. betw. Beaver and Forks, Clallam Co., at $70,752.

Wn., Seattle—Olympia Construction Co., 1326 Northlake Ave., awarded contract for grading, paving, etc., at $324,604; C. L. Creelman, 1079 25th Ave. N., awarded contract for grading on 48th Ave. S. W. et al, at $20,833.

W. Va., Charleston—Road contracts aggregating more than half a million dollars awarded by State Road Comn., as follows: Greenbrier Co. Crawley-Clintonville Rd., 3 miles, to Joe Carola, Ronceverte, at $21,260; Boone Co., Danville-Peytona Rd., 4.6 miles, to L. J. Chandler Co., Virgilina, Va., at $71,034; Pocahontas Co., Huntersville-Knapps Crk. Rd., 4 miles, to L. J. Chand'er Co., Virgilina, at $36,713; Monongalia Co., Morgantown-Pt. Marion Rd. 5 miles, to Keeley Constr. Co., Clarksburg, at $48,298; Jackson Co., Ripley-Fairplain Rd., 2 miles, Keeley Constr. Co., Clarksburg, at $62,516; Marshall Co., Moundsville-Taylor's Ridge Rd., 2 miles, to Stringer & Springer, Moundsville, at $42,000; Calhoun Co., Grantsville-Arnoldsburg Rd., 3 miles, Cavin & Powers, Charleston, at $13,825; Grant Co., Pendleton Co. line to Pansy Rd., 4.4 miles, H. N. Schilesley, Johnstown, Pa., $41,220; Morgan Co. Berkeley Springs-Hancock Rd. 3.3 miles, Souder Constr. Co., Lancaster, Pa., at $86,279; Cabell & Wayne Cos., Huntington-Hodge Crk. Rd., 4.5 miles, Keeley Constr. Co., Clarksburg, $129,852.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Fort Payne—Coker, Gamble & Brown, Chattanooga, Tenn., awarded contract to constr. san. sewers, pave walks, etc., at $27,000.

Cal., E. San Diego—Hickey & Harmon, San Francisco, awarded contract for constr. of approx. 30 miles of lateral sewers in East San Diego, at about $232,000.

Cal., Santa Ana—B. R. Ford, Santa Ana, awarded contr. for constr. of vit. pipe sewer in Greenleaf Ave. and other streets involving 2,485 ft. 8-in. pipe at 80c ft; 2,820 ft. 6-in. pipe at 70c ft.; 5 manholes at $100 each; 2 flush tanks at $110 each and 2 lampholes at $15 each.

Cal., Taft—Harron & Hayes, 259 15th Ave., San Francisco, awarded contract for constr. reinf. conc. septic tank for city at $14,888.

Ont., Dunnville—Webster Constr. Co., Ltd., Bank of Toronto Bldg., London, awarded contract for sewers at $8,810.

Ont., Hamilton—J. D. Armstrong, 871 Main St., E. awarded general contract for constr. of sewers on Proctor Blvd., Main St. and alley for City, at $8,500.

Que., Montreal—A. Di Cesar & Co., 885 St. Catherine St. E. awarded contract for constr. of sewer at $23,110 on Harvard Ave. from Monkland Ave. to Cote St. Luke Rd., also contr. for constr. of sewer on Coronation St., at $8,643; C. Perluzzi, 26 Sevignac Lane, contr. for sewer constr. on Berri St. Blvd. at $5770.

Que., St. Lambert—Messrs. Leger, 76A Aird Ave. and Tardif, 60 Adams St., Montreal, awarded general contract for san. sewers, at $15,000.

Fla., Dunedin—Jas. G. Yeats Co., Port Tampa City, Fla., awarded contract to extend sewer system at $16,873; constr. 6, 8 and 10-in. san. and 12 and 15 in. storm inlets; including manholes, flush tank and disp. plant. Geo. S. Iredell, Engr., 316½ Franklin St., Tampa.

Fla., West Palm Beach—J. C. Mishler, awarded contract for constr. of sanitary sewer in district No. 2, at $60,337.

Ida., Boise—Morrison & Knudson, awarded contr. for constr. of north side drain sewer system.

Ill., Dixon—American Plumb. and Heating Co., E. St. Louis, awarded contract for constr. of sewer on Fifth and Sixth Sts. on Diron Ave., at $4,180.

Ill., Mt. Olive—John Keeley Co., E. St. Louis, awarded contract by Bd. Local Impvts. for constr. of sewer at $82,400.

Ind., Indianapolis—Following contracts let by Bd. of San. Commrs.: Scott Elec Co., City, Contract for switchbd., elec. wiring, equipt. and conduits, at $4,389; 4 motors to Dravo-Doyle Co., Pittsburgh at $2,300 and 2 centrif. pumps, Midwest Engine Co., at $1,776; screen drive from Chain Belt Co., Milwaukee, at $2,650.

Mass., Boston—Jas. Barletta awarded contract for sewerage works in Public Alley 817, from Gainsborough St. 370 ft. westerly, Roxbury, at $6,053.

Mo., Kansas City—Halpin-Boyle awarded contract to construct sewer within the boundaries of 65th and 72nd Sts. and Oak and W. Pennway Ave., at $16,985.

Mont., Livingston—McLaughlin & O'Neil, Livingston, awarded contract for constr. of storm sewers in Special Impvt. Dist. 101. Approx. 212

lin. ft. 8-in. pipe for inlets; 1,367 lin. ft. 8 to 30-in. ft.; 4 conc. manholes; 10 inlets with catch basins, also for paving and appurtenances, at $34,000.

Neb., Omaha—J. J. Hanighen Co., 617 S. 14th Omaha, awarded contract for constr. of sewer from 19th and Pierce Sts to 16th and Mason Sts. thru tract whereon C. R. I. & Pacific R. R. Co. will build freight terminals, at $26,499.

N. C., Elizabeth City—A. H. Guion & Co., Gastonia, N. C., awarded contract by Bldg. Comm., St. Normal Sch. for Colored, to install sewer and water systems, at $18,000.

Pa., Philadelphia—Jos. Lombardi, awarded contract for sewer constr. in sections of 3 streets, at $90,000; also contract for constr. of branch sewer on Kensington Ave., at $23,000.

Tex., Beaumont—Howard Kenyon Dredging Co. Houston, awarded contract to construct storm sewers in western section; 15,000 cu. ft. 4 to 7x8 ft. conc. storm sewers; install 4 draing. mains on Wiess Ave. 8th St. Carley Ave., etc., at $261.967.

Tex., Houston—H. A. Kipp awarded contract for constr. of sewer on Yuon St., at $1,839; Kroeger & Hayner, San Antonio, awarded contr. for constr. of sewer on Pease Ave., at $5,642.

Utah, Salt L. City—John O'Connor Co., Fargo, N. D., awarded contr. for constr. of sewer system at $100,000.

Va., Richmond—Claiborne & Taylor, awarded contract to construct Canal Run sewer sections Nos. 1, 2 and 3, Brookland Park Blvd. sewer at $63,000; Fulton Dist. sewer, at $11,000; C. M. Henley, at $22,000 to constr. Oak Grove sewer, sects. 1 and 2. Canal Run sewer will cost $83,000.

Wn., Spokane—Miracle Concrete Constr. Co., Great Falls, Mont., awarded contract for constr. of downtown sewer at $318,000.

Wis., Shullsburg—Gray-Robinson Constr. Co., Manitowoc, awarded contract for san. sewers at $16,000.

WATER SUPPLY AND PURIFICATION.

Cal., Anaheim—U. S. Cast Iron Pipe & Foundry Co. awarded contract for 672 ft. 12-in., 11,216 ft. 10-in. and 400 ft. 6-in. Cl. C cast iron pipe at $46.65 ton for pipe and average of $20.12 each for fittings, f. o. b. Anahelm.

Cal., Los Angeles—The Crane Co. awarded contract for furnishing 2,200 ft. 4-in. black dipped wrought iron pipe at $51.40 per 100 ft. immediate dellvery; also contr. for 7,000 ft. 2-in. black dipped wronght iron pipe at $14.75 per 100 ft.

Cal., Los Angeles—Lacy Mfg. Co. awarded contract for riveted steel tank for Bd. Pub. Service, at $8,500.

B. C., Saanich—Yarrow's, Ltd., awarded contract conditionally by Council, for material necessary for constr. of Gordon Head water extension, at $69,720; Marine Iron Wks. awarded contract for 50 hydrants at $46 each. First named contract also included piping and special castings.

B. C., Sumas—Canadian Fairbanks-Morse Co., Ltd., 1400 Broad St., Victoria, awarded contract for installation of pumping costing $16,000 for Sumas Dykling District.

B. C., Vancouver—Vulcan Iron Works awarded contract for supplying city with 2,000 ft. 32-in. and 33-in. pipe, at $7.82 for larger and $6.13 for the smaller size.

Ill., Rockford—Sword Bros. awarded contract for air lift suction pump for new water works, at $7,441; also contract for valves for discharge at suction line, at $3,112; U. S. Cast Iron Pipe & Foundry Co., Chicago, awarded contract for furnishing plpe and fittings at $5,100.

Ia., Davenport—McCarthy Well Co., local, awarded contract for drilling artesian well, at $9,310. Well will be at least 1,650 ft. deep with 12-in. top graduating downward to 8 inches in diam. It will be lined with iron pipe.

Miss., Natchez—Corless Well & Supply Co., Memphis, Tenn., awarded contract for drilling well to supply plant; ultimate capy. 200,000 gals. water. Foundation started for turbine, 1,000 additional h. p. Contr. awarded by National Box Co., (Robt. Perry, Res. Mgr.)

Neb., Lincoln—A. A. Dobson Co., 809 1st Natl. Bk., Lincoln, awarded contract for water mains on South St.—Jefferson Ave. to 60th St., Normal Addn. Abt. 2¼ miles long. Wk. just started. $20,000.

Neb., Page—Following contract let for machinery and pumphouse for water works system: Engine, to Townsend Bros., Page; Pump complete, to Keystone Driller Co., 53 W. Jackson, Chicago, Ill.

N. C., Elizabeth City—A. H. Guion & Co., Gastonia, N. C., awarded contract by Bldg. Comm. of State Normal Sch. for Colored, to install water and sewers systems, at $18,000.

Tex., Newcastle—Groves & Young awarded contract to construct 90-ft. conc. spillway for dam. City will constr. filtr. plant.

Va., Staunton—DeLaval Steam Turbine Co., Trenton, N. J., awarded contract for pump for water works, at $3,600.

Prospective Work

ROADS AND STREETS.

Cal., Pomona—City plans to expend about $200,000 for approx. 14 miles of city street impvt. Streets in business section of city will be first to be paved.

Cal., Sacramento—At joint meeting of representatives of Utah, Nevada, California Hwy. Assn. the Victory Hwy. Assn. and Good Rds. Comm. of local Chamber of Com. decided that the Association would make a drive for $150,000, starting immediately after the 1st of year, for constructing road across northern portion of Nevada in those districts where ther are not enough people to supply funds necessary in order to receive federal aid. $15,000 of the amount will be used for purchasing, equipping and paying expenses of a maint. truck to keep rd. in Nevada open throughout the year.

Colo., Denver—State will expend $1,215,420 for maintenance of 7,316 miles of roads. Colorado counties will contribute $607,710 of total. In addition state will set aside $100,000 to meet emergencies.

Del., Dover—State Hwy. Dept. announces construction program of $2,250,000 for 1922. First contract letting last of February. C. D. Buck, Chf. Engr.; I. Paul Jones, Secy.

Fla., Titusville—State Road Dept., Tallahassee, Fla., authorized $300,000 for road constr. and bldg. brdg. $600,000 available. N. T. Froscher, Co. Clk., Circuit Court.

Fla., Madison—Madison Co. will hard surface 60 miles and sand-clay 153 miles hwys. $750,000 bonds voted.

Idaho—Lewiston—Nez Perce Co. Commrs. ordered that county furnish its proportionate share, in conjunction with state and fed. hwy. departments, for bldg. part of North and South state hwy. from west line of Evergreen Hwy. Dist. near Winchester down hill to Culdesac about 12 miles, at est. cost of $440,000. Nez Perce County's share is $73,333 or one-sixth.

Ida., Nampa—Another special election may be called to vote on bonds for purpose of improving various streets by surfacing, graveling and draining. Petitions also call for paving of about 20 blks. of streets of city.

Ill., Bloomington—City plans expendt. of $339,000 for public impvts. pavements, sewers, water mains, etc., included.

Ill., Champaign—City making plans for paving W. Clark St. with concrete, $30,000. F. C. Lohman, City Hall, Engr.

Ill., Waukegan—Lake County making plans for bit. conc. pavement 5 mile rd. west from Gurnee, 18 ft. $150,000; 2.5 mile rd. from Highland Park to Deerfield, 24 ft. $75,000; 2.5 mile rd. from Highwood west to Telegraph Rd., 18-ft. $75,000. C. M. Powell, Waukegan, Engr.

Kans., Topeka—New hwy. sys. for state has been worked out by State Hwy. Comn. State Comn. will receive $2,000,000 additional for rd. bldg.

Mich., Lansing—Program for road constr. by State Hwy. Dept. in 1922 is as follows: one course gravel or stamp sand, 135.0 mi.; gravel, 391.83 1/3 mi.; stone gravel, 2.5 mi.; macadam, 44.1 mi.; bitum. mac. 2.4 mi.; penertation 13.0 mi., conc. 241.9 mi.; brick 0.33 1/3 mi., grading and draing. structs, 95.75 mi.—total 926.91 2/3 miles. Leslie H. Belknap, Deputy St. Hwy. Commr.

Minn., Duluth—Will soon ask bids for 3 paving

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bituilithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Koleech & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Canneiton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brosemann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Canneiton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

contracts contemp. for 1922. Superior Street—8th Ave. W. to 3rd Ave. E. Est. cost $185,118 (brk. to be used); Woodland Ave.—Oxford to Austin Sts. conc. surface. Est. cost $100,000. Roosevelt St.—51st to 59th Ave. W. Est. $73,000. J. A. Farrell, Commr.

Miss., Moss Point—Plans under way for immediate constr. of hard surfaced road from east end of Tarvia road in Moss Point to plant of Southern Paper Co. by mayor and bd. of aldermen. Route covers abt. 2 miles. Surfacing material will probably be slag treated with Tarvia.

Neb., Lincoln—Two ordinances introduced for first reading which, if passed, will authorize issuance of $115,280 paving bonds.

Neb., Lincoln—State made offer to Lancaster County Board to build 10 mile stretch of gravel road in Lancaster Co. at cost. Co. Commrs. and Co. Engr. in favor of proposition. Geo. Leonard, Asst. State Engr., and E. H. Morey, St. Supt. of Rds. & Bridges.

Okla., Ardmore—Carter County has voted $500,000 for constr. of hard surfaced roads and R. J. Edwards, Ardmore, is preparing plans for the work. As soon as approved by Hwy. Dept. bids will be asked.

Okla., Fairfax—V. V. Long & Co., preparing prelim. plans for 90,000 sq. yds. paving. Est. cost $530,000. E. C. Quigley, City Clk.

Okla., Okla.—Word has been received by E. B. Clark, State Hwy. Commr. that the Secy. of Agricult. has approved state hwy. proj. No. 40, McCurtain Co. Project is approx. 70 miles in length extending from Idabel thru Broken Bow and Eagletown to Ark. line. It is to be built of gravel. As soon as plans are returned from Washington bids will be advertised.

S. D., Sioux Falls—Minnehaha Co. making plans for 1922 road program which includes 35 miles grading and graveling on Wash. Hwy.

Tex., Tyler—Proceeds from sale of Smith Co. Rd. bonds, amounting to $300,000, have been received by local banks and money together with $100,000 Fed. aid, will be used in bldg. Jim Hogg Hwy. thru County from Wood Co. to Cherokee Co. lines. Actual work will begin very soon.

Wn., Chehalis—Lewis Co. Commrs. have set aside $50,000 to be used co-operatively with fed. aid and state funds in constr. of Ocean Beach Hwy. from Chehalis to Adna for 4.5 miles.

Wn., Seattle—Douglas County Engr. Wm. H. Long reports following as important road work calendared for 1922 by Bd. of Douglas Co. Commrs.: 1—Sunset Hwy. Sec. 3, resurfacing with crushed rock approx. 3 miles, Beard to Grant Co. line. Approx. cost $4,000; (2) Dyer Hill Hwy. surfacing with crushed rock 3.1 miles. Approx. cost $11,000; (3) Perm. hwy. No. 10, grading, draining and surfacing with crushed rock or gravel 9.1 miles Mansfield to Bridgeport. Approx. cost $65,000—Total approx. cost, $80,000.

Wn., Vancouver—Co. Commrs. have ordered impvt. of road by laying concrete 18 ft. wide along St. Johns River from city limits 3 miles to Tracy Rd. Est. cost $75,000.

Wis., Appleton—Outagamie Co. Board has appropriated $20,000 for purch. of small tools and equipt. for co. garage and mach. shed, $93,924 voted for county aid road work in 1922. G. Brusewitz, Appleton, Commr.

Wis., Kenosha—Kenosha Co. Bd. has appropriated $20,000 for purch. of road machy. for 1922, including one truck, large grader and cement mixer. Jno. F. Herzog, Kenosha, Commr. Kenosha County Board has voted $165,000 bonds for impvt. of 18 ft. conc. (Geneva) Road, town of Salem—5½ miles. Road, town of Salem—5½ miles. Jno. F. Herzog.

Wis., Madison—Dane County Board has voted state aid road constr. program for 1922 of $124,828. E. J. Smith, Madison, Commr.

Wis., Manitowoc—Manitowoc Co. has appropriated $19,000 for purch. of road machinery, including two tractors, two trucks, three small graders. Jos. Connell, Manitowoc, Commr.

Wis., Milwaukee—Milwaukee Co. Board voted county and state aid rd. constr. program for 1922 of $377,860. W. F. Cavanaugh, Pereles Bldg., Milwaukee.

Wis., Milwaukee—Contemplate constr. of 30-mile driveway around Milwaukee and connect all Milwaukee parks and suburbs. Plans of Co. Park Comn. C. B. Whitnall, Secy.

Wis., Port Washington—Ozaukee Co. Bd. has appropriated $10,000 for purchase of road machy. for 1922. W. J. Ubbink, Pt. Washington, Commr. County has also adopted state aid and co. bond issue to constr. rds. for 1922 of $117,813.

Wis., Sheboygan—Sheboygan County Bd. has appropriated $30,000 for purch. of new machy. for 1922 and $20,000 for purch. of road oil. Geo. W. Ubbelohde, Sheboygan, Commr.

Wis., Superior—Douglas Co. Bd. passed state aid bond issue for road constr. program for 1922 of $368,195. Conrad Hanson, Superior, Wis., Commr.

Wis., Waukesha—Waukesha Co. Bd. adopted county and state aid road constr. program for 1922 amounting to $1,369,561. Chas. J. Hann, Waukesha, Commr.

Wis., West Bend—Washington County board adopted state aid and co. bond issue for oad constr. program of $329,344.

Wis., Wisconsin Rapids—Wood County Board adopted state aid and county bond issue for road constr. amounting to $936,521. Ed. Morris, Wisc. Rapids, Commr.

Wisconsin—Rd. machy.: Waunpaca County Bd. has appropriated $20,000 for purch. of rd. machy. for 1922. Jno. Huffcut, Commr, Waupaca; Calumet Co. Bd., $4,000. Wm. Hoenig, Chilton, Commr.; Monroe Co. Bd. $10,000. Chas. H. Millard, Sparta, Commr.; Sauk Co. Bd. $40,000 for rd. machy. which includes 2 crushers, tractor and small graders. E. H. Groth, Baraboo, Commr.; Waukesha Co. Bd., $16,400 for rd. machy. Chas. J. Hahn, Waukesha, Commr.; Green Co. Bd. $85,000 for rd. machy. and $111,443.03 for road constr. program. Chas. J. Smith, Commr. Monroe; Langlade Co. Bd., $10,000. Chas. Olsen, Antigo, Commr.; Burnett Co. Bd. $1,000 for rd. machy., including patrol graders and gravel loaders. Geo. E. Miller, Webster, Commr.; Dodge Co. Bd. $5,000 for rd. machy., including crushing outfit. E. T. King, Juneau, Commr.

SEWERAGE AND SEWAGE TREATMENT

Md., Catonsville—Baltimore Co. Commrs., Towson, Md. considering installing sewer system, $700,000 to $800,000.

Minn., Deer River—Village will install sewer system from south end of 2nd St. in Easttown to Taylor Ave. on 1st St. N. with outlet in Deer River. W. S. Runyon, City Clk. Est. cost $38,000.

Minn., Virginia—Will call for bids for san. sewer extending 1,670 feet from hosp. to Williams Addn., $24,661; also for enlarging sludge beds at purification plant, $7,500. City Engr. E. F. Johnson; Elmer Matheson, Chrmn. St. & Alley Comn.

N. C., Hamlet—City plans expending $80,000 to install sanitary sewers, pave streets, etc.

N. C., Southern Pines—City will improve sewer and water systems; plans issuing $25,000 bonds. Gilbert White, Engr. Durham.

N. D., Carrington—Will call for bids in spring for sewage disposal plant. Cons. Engr. L. P. Wolff, 1001 Guardian Life Bldg., St. Paul, made plans. C. C. Carnahan, City Clk.

Okla., Watonga—$20,000 san. sewer system bonds have been issued here.

Pa., Beaverdale—Plans under way for installation of modern sanitary sewerage system in town. H. H. Griffith, Conemaugh, Pa. is head of movement and State Health Officer of this Dist.

Pa., New Castle—Petition of So. First St. residents in 7th Ward for san. sewer, presented to Council. City solicitor instructed to draw up Ord. to get work under way.

Tenn., Memphis—City will construct sewers in Randolph Subdiv. C. C. Pashby, Clk. Rowlett Paine, Mayor.

Tex., Amarillo—Work will soon start on extension of san. sewer system. $60,000 bonds voted.

Tex., Robstown—Plans being prepared for installation of modern sewerage system and disposal plant. $60,000 to $100,000 will be voted on by citizens. E. E. Sands, Houston, Engr.

WATER SUPPLY AND PURIFICATION

Ala., Geneva—J. H. Hardaway, Columbus, Ga., proposes erecting dam at Chalkers Bluff; Geneva Co.; 30 ft. high, developing 1600 to 1800 minimum H. P.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Fluehers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Ark., Conway—Report filed with City Council showing est. cost of impvts. to water system. Work will include replacing wooden water mains with iron mains. E. V. Sharp City Council and for tha iron mains. E. V. Leverett, Supt. of Water Wks.

Ark., England—Town Council has passed Ord. providing for impvt. of water works system. Work will include additional well, laying water mains and installing fire hydrants. J. R. England, Mayor; Tom Swain, City Clerk.

Ark., Ft. Smith—City (Fagan Bourland, Mayor) plans to constr. dams across Poteau River above Mill Creek.

Cal., Los Angeles—Fred A. Ballin, Portland, Ore. (shipbuilder) will construct giant pipeline proj. 75 miles in length extending from Bakersfield to Monolith. Project will be unique in Calif. engrg. records. It will require 8 months to complete and will cost betw. $500,000 and $1,000,000 according to prelim. estimates.

Man., Brandon—City Council has decided to proceed with constr. of sewers and water mains in northern end of City. H. Brown, City. Clk.

Ont., London—City will construct aerator and settling basin costing $10,000 on Horton Street. E. V. Buchanan, Mgr. Utilities Comn.

Ont., Ottawa—Bd. of Control recommended to City Council the installation of water mains in territory bounded by Nolland Ave., city limits, Spencer St. and Scott. Est. cost of work $42,325.

Ont., Petrolea—Citizens voted in favor of by-law of $40,000 for electrification of the pumping station at Lake Huron, using hydro-power and bldg. reservoir.

Del., Holly Oak—Holly Oak and Gwynhurst Dists. plan installation of water system.

Fla., Crescent City—Town will install water works and erect electric plant addn.; constr. 60,000-gal. conical tank on tower 100 ft. to bottom of tank; lay 13,000 ft. 6-in. cast iron mains and 1700 ft. 8-in. mains with necessary fittings; 31 two-way hydrants. $40,000 bonds. A. B. Harbison, Chrmn. Board Trustees.

Fla., Sebring—City will purchase water works. Will issue $100,000 bonds.

Ga., Atlanta—City expects to spend $1,800,000 for water works improvements during 1922. City will provide 21,000,000 gal. daily capy. filter basin and 10,000,000-gal. capy. clear water basin.

Ga., Milledgeville—City has acquired water works and will reconstr. Will install filter system. J. B. McCrary Engrg. Co. Engrs., Atlanta.

Ga., Valdosta—F. E. Hatch, Albany, Ga., will develop hydro-electric power on property known as Banks Mill Pond.

Ill., Lyons—City proposes constructing reservoir, pumping station and 4-6-in. cast iron mains. About $40,000. E. Hancock, 2047 Ogden Ave., Chicago, Cons. Engr.

Ia., Oskaloosa—City will get new water supply from Des Moines river, 7 mile pipe line, filtr. plant. Engrs. Burns & McDonnell, Interstate Bldg., Kans. City, Mo., to make estimates. T. H. Carlin, City Clerk.

Ia., Storm Lake—Plans under way for water works impvts., which include 250,000-gal. elev. steel tank, 100 ft. steel tower, duplicate pump units 400 gal. per min. each, new intakes, impvt. of filtr. units. Cons. Engr. W. E. Buell Co., 205 Davidson Bldg., Sioux City. Complete plans about Jan. 15. Roy Kinne, City Clk.

Jamaica, Kingston—Government of Jamaica plans to expend $1,750,000 for extension of sewerage and water systems of Kingston. Power station estimated at $180,000 will be erected and street lighting will be improved.

Mo., Odessa—City will probably soon advertise for bids for impvts. to water works system. $100,000 bonds recently voted. E. E. Harper, 3031 Park Ave., Kans. City, Mo., Cons. Engr.

Minn., Sauk Center—Meeting held to discuss plans for impvt. of water works system. Cons. Engr. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, recommend reservoir on north side river, 30 feet deep, 40 feet across and 150,000 gal. conc. and steel standpipe at Grove Lake Ave. J. F. Cooper, City Clk.

Mo., St. James—Comm. on water, sewerage and light submitted report at meeting of Board of Aldermen. Div. of money made as follows: Water works consisting of deep well, elec. pump. brk. pump bldg., 75,000-gal. tank on a 100-ft. tower, these to be constructed on city lots, water mains and water departments—$200,000 for Light Dept. sepic tank, $10,000, etc., etc.

Neb., Lincoln—Resolutions passed by City Council authorizing a $300,000 bond issue for city light and water department—$200,000 for Light Dept. and $100,000 for Water Dept.

Neb., Palisade—Jim Fitzgerald and H. L. Hunt appointed by Mayor to prepare plans and call for bids for constr. of city well. H. L. Hunt, Clerk.

N. C., Raleigh—City will construct 250,000,000-gal. impounding reservoir at Yates Mill; constr. addition to dam; increase capy. of Lake Raleigh from 171,000,000 to 250,000,000-gals.; remove present intake to Lake Raleigh; increase capacities of pumping and filtr. plants from 3,000,000 to 5,000,000 gals.; erect 750,000-gal. capy. steel tower. Approx. total cost $500,000. Wm. C. Olsen, Cons. Engr., Kinston, N. C.

N. C., Southern Pines—City will improve water and sewer systems; plans issuing $25,000 bonds. Gilbert White, Durham, N. C., Cons. Engr.

N. C., Warsaw—City plans improving water and electric lighting systems; will issue $25,000 bonds.

Okla., Mill Creek—$50,000 bonds voted for installing water works.

Ore., Salem—City of Eugene, thru its Water Board, applied to St. Engr. Percy A. Cupper, for permission to appropriate 2.900 second ft. of water from McKenzie river to power development. First application is for 2,500 second ft. and it is evident that dam will be constructed 75 ft. high and 300 ft. long with a spillway.

S. D., Vermillion—Prelim. survey made for sinking reservoir in sand basin across Vermillion river, water supply from Missouri. Will connect with present pump plant by iron mains. J. W. Brown, Vermillion, submitted plans. C. L. Vaughn, City Clk.

S. D., Watertown—Prelim. plans made for impvts. to filtr. plant and pumps. Geo. K. Burt, Secy. of Pub. Utilities Comn. $50,000.

Tenn., Chattanooga—City Water Co.—M. F. Riley, Pres.—will improve water works, extend mains; improve pumping station, etc. Approx. cost $100,000.

Tex., Corpus Christi—Nueces Co. water impvt. Dist. No. 3 will improve water works and irrigation. $300,000 bonds voted.

Tex, Galveston—H. L. Durland, Cons. Engr., will be retained by City to prepare plans and specfs. for installation of new plant (Alta Loma water plant). Bids will be advertised for oil engine plant. Approx. cost $117,000.

Tex, Walnut Springs—Among impvts. planned for new year is complete water system, a petition signed by large majority of voters having been presented to City Council.

Va., Richmond—City will extend water works; enlarge storage facilities; $1,500,000 bond issue approved.

Va., So. Boston—City will expend about $50,000 to extend water mains. R. R. Hamilton, Archt., Box 64. E. R. Farmer, Engr.

W. Va., Huntington—Huntington Water Co. plans expendt. of $375,000 to improve water works; install pump at 24th St. station; increase capy. o 5,000,000 gals.; 2 filters, increasing filtr. capy. 25 per cent; conc. sedimentation basin; 12 to 16-in. main from pumping station to reservoir.

Wis., Fall Creek (P. O. Bracket)—Prelim. plans under way for sewer and water system. Archt.-Engrs. Toltz, King & Day, Inc., 1410 Pioneer Bldg., St. Paul, Minn. Pump house, tower 80 ft. high, tank 80,000 gals. steel water mains and hydrants and sewage disposal plant. Will build next spring. $50,000.

Wis., Waupaca—Plans under way for new water supply system. W. G. Kirchoffer, Cons. Engr., Madison, recommends gravel-packed well, 30 ft. diam., 36 ft. deep, capy. 1,100 gals. May purchase new house meters and 1 or 2 pumps. F. A. Houseman, City Clk. Est. cost $28,500.

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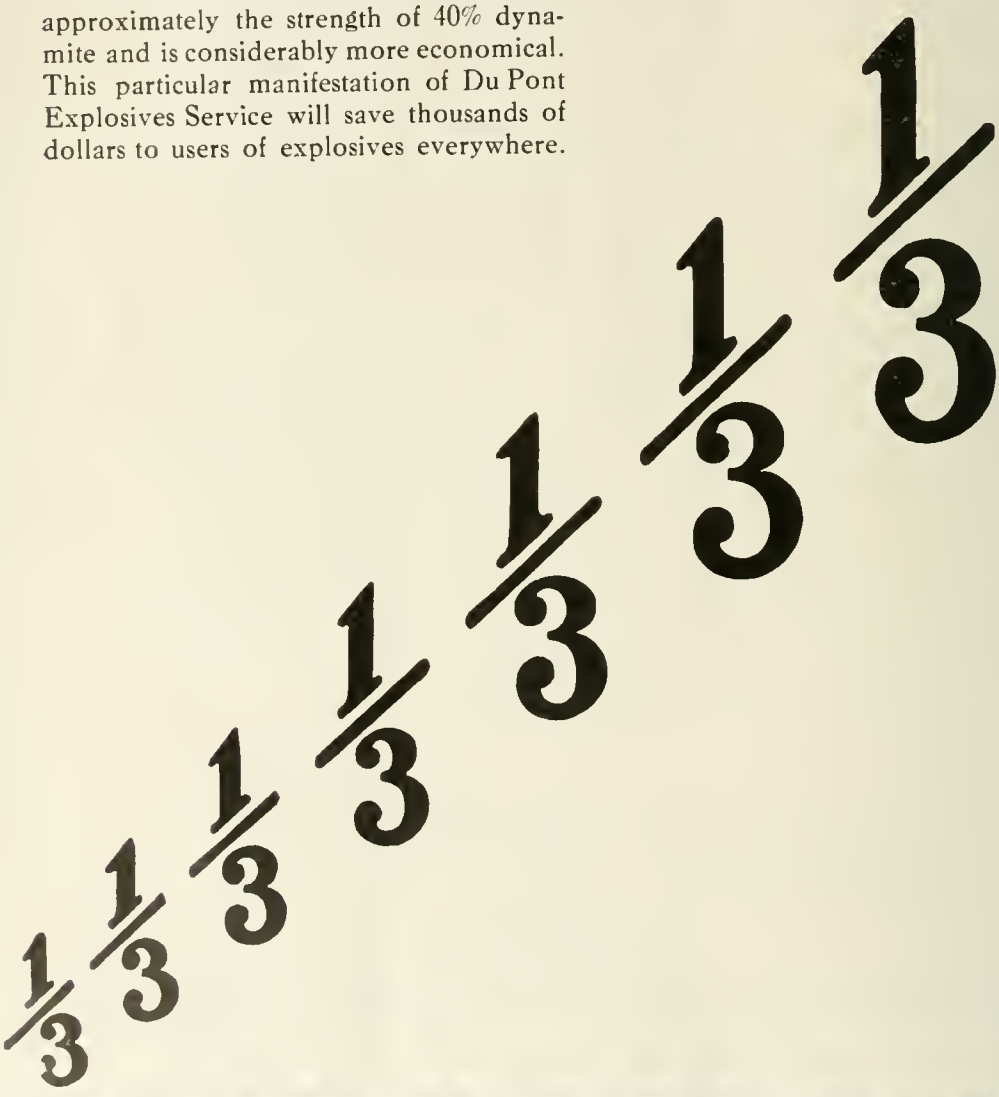

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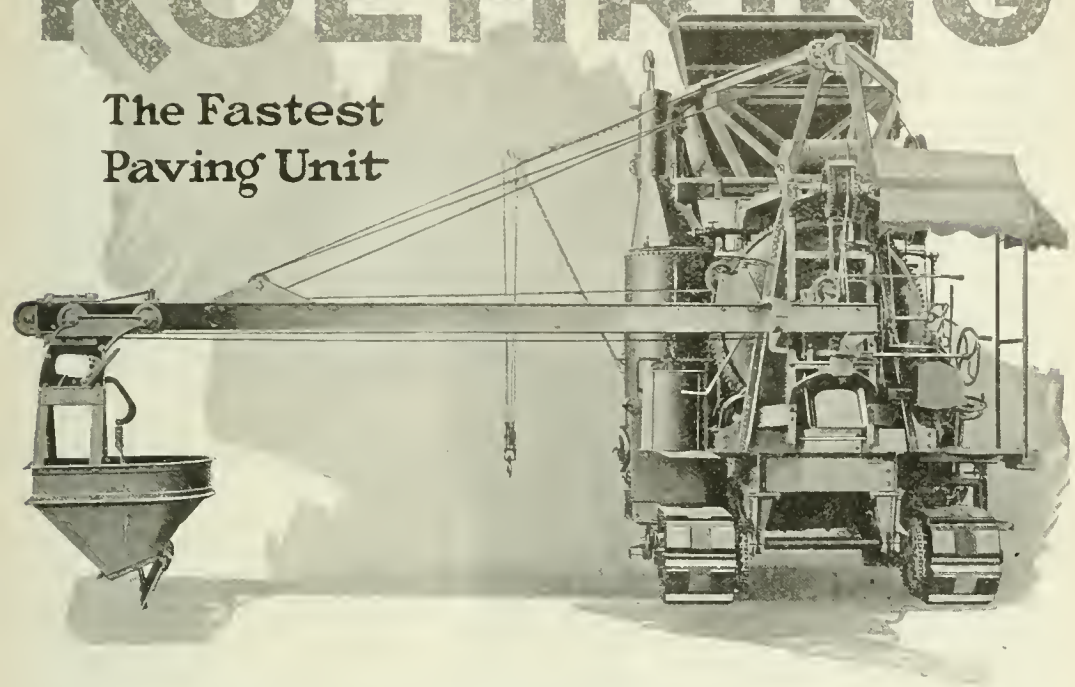

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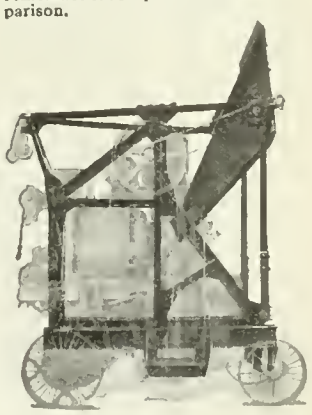

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One essential element in this process is the elimination of needless styles and varieties of all products.

The Paving Brick industry, with the co-operation of the users of its product, is the first industry to meet the Government's request and present a comprehensive schedule which recommends the elimination of 55 needless varieties of paving brick, by "mutual consent" of manufacturers and users.

This keynote performance has set the pace for all other industries.

The remarkable conference in Washington last November, and at which definite action was taken, was participated in by:

American Association of State Highway Officials
American Ceramic Society
American Electric Railway Engineering Association
American Engineering Council
American Engineering Standards Committee
American Institute of Architects
American Institute of Mining and Metallurgical Engrs.
American Society of Civil Engineers
American Society for Municipal Improvements
American Society for Testing Materials
Columbus (O.) Engineers' Club
Federated American Engineering Societies
Indiana Engineering Society
National Paving Brick Mfrs. Association
U. S. Chamber of Commerce
U. S. Bureau of Mines
U. S. Bureau of Public Roads
U. S. Bureau of Standards
U. S. Department of Commerce
U. S. Army
U. S. Navy
Western Society of Engineers

The 11 standards of this conference were ratified by the National Paving Brick Manufacturers and adopted as the Standards of this Association by formal action at Pittsburgh, Pennsylvania, December 7, 1921. They are as follows:

PLAIN WIRE-CUT BRICK (VERTICAL FIBRE LUGLESS)

Width		Depth		Length
3″	x	4″	x	8½″
3½″	x	4″	x	8½″

REPRESSED LUG BRICK

Width		Depth		Length
3½″	x	3½″	x	8½″
3½″	x	4″	x	8½″

VERTICAL FIBRE LUG BRICK

Width		Depth		Length
4″	x	3″	x	8½″
4″	x	3½″	x	8½″

WIRE-CUT LUG BRICK (DUNN)

Width		Depth		Length
3½″	x	3″	x	8½″
3½″	x	3½″	x	8½″
3½″	x	4″	x	8½″

HILLSIDE LUG BRICK (DUNN)

Width		Depth		Length
3½″	x	4″	x	8½″

HILLSIDE LUG BRICK (REPRESSED)

Width		Depth		Length
3½″	x	4″	x	8½″

A COPY OF THESE PROCEEDINGS will be sent to you upon request and will bring you knowledge and understanding of rapid development up to date.

The burned-in service value of vitrified Paving Brick is matched by the aggressive Public Service spirit of the Paving Brick industry.

Natl. *PAVING BRICK* Mfrs. Assn.
804 Engineers Building Cleveland, Ohio

Eastern Paving Brick Manufacturers Association, Lincoln Building, Philadelphia, Pa.
Illinois Paving Brick Manufacturers Association, Chamber of Commerce, Chicago, Ill.
Indiana Paving Brick Manufacturers Association, Fidelity Trust Bldg., Indianapolis, Ind.
Ohio Paving Brick Manufacturers Association, Hartman Building, Columbus, Ohio
Southern Clay Manufacturing Company, Volunteer Building, Chattanooga, Tenn.

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After exhaustive investigation, the South Park Commissioners selected "Caterpillar"* Tractors for grading Grant Park, Chicago's famous front yard. With "Caterpillars,"* every phase of the work is being speeded up; greater daily yardages are being handled and real savings over other methods are being shown. It is significant that after a similar study of machines, methods and costs, "Caterpillars"* have been adopted by New York, Duluth, Dallas, Minneapolis, Spokane, and many other cities and towns for public works of all kinds where economy is the great essential. Let us show you our new motion picture, "Bureau County Knows How," or send you our booklet, "'Caterpillar'* Performance."

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STOCKTON, CALIF.

* *There is but one "CATERPILLAR"—Holt builds it*

ATLANTIC CITY AND

St. Charles Place, Atlantic City, N. J., leading to the Beach. Constructed in 1913. A perfect street today.

At Atlantic City—A rolling, foaming, enjoyable surf, refreshing at sight, and invigorating to the bather.

At Atlantic City—A wide, well cared for, seemingly endless Boardwalk, skirting the ocean, open to the cool, inviting ocean breeze. This is the promenade of the vacationist, the tourist, and the pleasure seeker of the world.

At Atlantic City—Six immense recreational piers, extending out into the ocean, offering every opportunity for rest and diversion under the most ideal conditions.

Pennsylvania Avenue, Atlantic City, N. J., terminating at the Boardwalk. Laid in 1913. A perfect street today.

All-year-'round, Atlantic City's mild, healthful, uniform climate, and its countless diversions draw hundreds of thousands from every corner of the world.

A natural result of this great and continuous influx of visitors is the accompanying influx of countless pleasure cars, numerous auto delivery trucks and the other forms of traffic associated with a thriving, enterprising resort.

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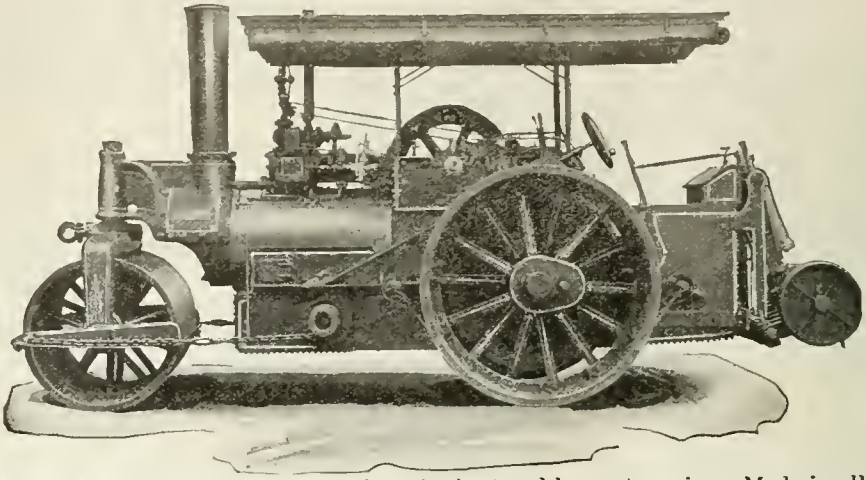
QUALITY ROLLERS



"Buffalo-Pitts" and **"Kelly-Springfield"** render best and longest service. Made in all types and sizes—steam and motor. Buffalo-Springfield Pressure Scarifiers are money-savers and can be furnished with new rollers or attached in the field to rollers already in use.

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ASPHALT

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Resilient
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Dustless
Weather-proof

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TRUCKS

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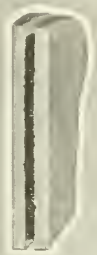
Buffalo, New York

2-ton $3200 3½-ton $4350 5-ton $4850 equipped



Sandwich construction makes this decidedly the best paving joint obtainable.

The joint is composed of a body of tempered asphalt compound sandwiched between two layers of felt which have been saturated with asphalt cement.

Because of these walls, the joint adheres to the paving better when the roadway contracts. In cold weather the wool felt will be found sticking to the paving with great tenacity, preventing frost from getting into the joints.

The walls of saturated felt also make the joint wear better at the road surface. They help keep the compound from being dragged away by traffic in hot weather, when the joint is compressed and bulged at the top by the expanding street.

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Elastite Joints do not stick together. Elastite Joints do not crumble or break in handling. There is no waste, no loss at all in installing.

Because Elastite does not melt and run in summer or become brittle and crack in winter; and because it absorbs all expansion and prevents cracking and buckling of streets, it is now used on all important national highways and the streets of leading cities everywhere.

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3-21

A-W Graders
AND
GRADER-SCARIFIERS

14 Models

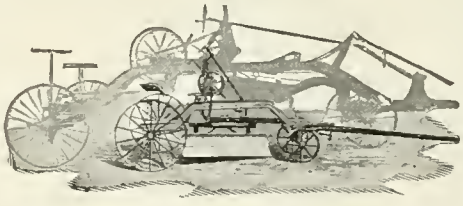
You don't have to look further than the first twenty-one pages of General Catalog No. 21-O to find the machine exactly suited to your needs.

The graders range in weight from the Midget at 1,000 pounds to the No. 20 at 9,000 pounds.

Scarifiers can be attached to all graders of at least standard size, but for a really efficient outfit, choose the Austin Rip Snorter, which scarifies and grades at the same time; or the Western Scarifier, big brother to a grader on the hardest jobs.

It will pay you to read the whole story of Austin-Western Graders.

Send for Catalog No. 21-O.



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"Everything from a Drag Scraper to a Drag Roller"

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Several great States have so ruled.

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Fulfills every engineering requirement.

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PIONEER Highest Quality ASPHALTS

PIONEER Highest Quality ASPHALTS

Filler Asphalt

The ideal brick pavement filler. Made to meet the strictest specifications. Low prices and immediate delivery on any quantity.

"PIONEER"

Every monolithic pavement should have an Expansion Joint. **"Pioneer"** is made from an absolutely pure asphalt, giving maximum expansion and contraction efficiency.

Expansion Joint

THE PIONEER ASPHALT CO.

LAWRENCEVILLE, ILL.

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FOR ROAD AND STREET WORK

A *Satisfactory* Tar Heater

Littleford Tar and Asphalt Heaters are selected by discriminating buyers because of the noticeable "built in" quality and the dependable service which they give. Each different type has been developed by our engineers to meet special demands in road and street construction or repair.

Hundreds of satisfied users tell of the long continuous service given them by Littleford Heaters. Sturdy construction of heavy plate steel makes them outlast any other make.

Be assured of receiving dependable heater service by ordering **Littleford** equipment. Complete descriptive information sent on request.

LITTLEFORD CONSTRUCTION HEATER
STYLE NO. 48

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THE CUMMER ROAD ASPHALT PLANT

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It spreads slag, stone or gravel from your trucks more evenly, quicker and more enonomically than men—and saves its cost on a mile of road.

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If in the market for any of the following highway construction equipment, so indicate by check marks, mail this page to *Municipal and County Engineering*, 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
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—Asphalt Tools
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—Bins, Portable Stone
—Bodies, Dump Truck
—Brick Rattlers
—Catch Basin Covers
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—Oil Distributors
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—Portable Drilling Rigs
—Pile Drivers
—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
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—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

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Highway Snow Plow

Clear the heaviest snowfall with horse, truck or tractor power. The **Phoenix Snow Plow** is built of selected hardwoods, reinforced with heavy forgings and castings. Adjustable wings for wide streets or narrow roads.

Sales Agents Wanted.
Write us today for complete information.

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Our small size machines are making money for the pit owner with a 100-ton per day market, just as our larger installations are for the car-load gravel shipper. Put your problem up to us.

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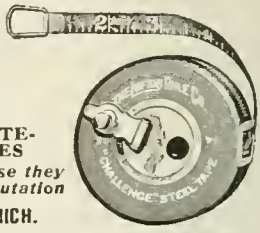

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More of them are in use than all other makes because they have for years consistently maintained the highest reputation

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For Sale at an attractive price, an Iroquois 2-unit portable asphalt plant; 3,000-gallon steam heated kettle; rated capacity, 800 yards, but has done 1,000 yards per day. Practically new; has done only one job of about 40,000 yards. The price should be very attractive to any contractor or city in the market for an asphalt plant.

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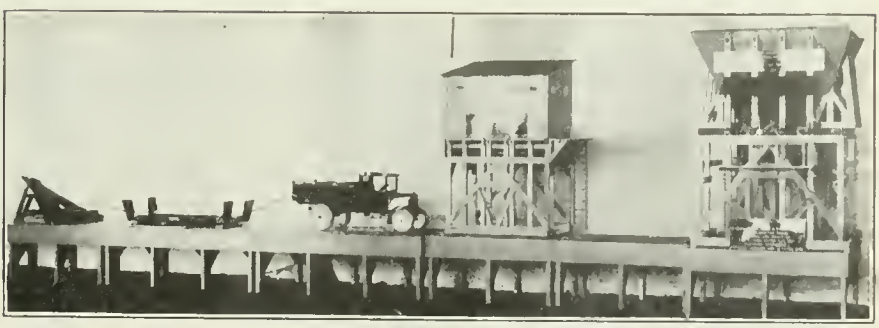
Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



VIEW OF MODELS OF KISSEL ROAD BUILDING EQUIPMENT EXHIBITED AT CHICAGO GOOD ROADS SHOW.

Motor Truck Operation and Accounting—78

METHODS AND COST OF MOTORIZED GARBAGE COLLECTION IN AKRON, OHIO, FOR 1921

By Frank C. Tolles, Superintendent Bureau of Public Works, Delaware Bldg., Akron, Ohio.

The City of Akron, Ohio, during 1921 effected a change in garbage collection methods with data resulting as to performance and to costs. A summary of these is here presented.

Akron has a population estimated at 165,000. It covers an area of 25 square miles and is of varied topography. Of its street mileage but one-third is surfaced.

During previous years garbage has been collected in Studebaker garbage wagons, which centralized to a single transfer station from which the garbage was relayed by 5-ton motor trucks with 10-yd. Lee side dump bodies to the point of disposal—in the present instance, a hog ranch located 9 miles from the loading station.

Following experiments throughout the summer and winter of 1920, there were purchased in 1921, 21 3½-yd. trailers of the Lee side-dump type, and 2 motor tractors—a Mack and a White. The purpose of the change was to lessen unproductive hauling time from collection route to transfer point—an average distance of 2.6 miles. As operated, a team provided with an empty trailer proceeds to the collection district, picks up its load and is then transferred to a second trailer spotted at a prearranged point. The filled trailer is later gathered into a train and drawn to the farm by one of the tractors. Trailers were used throughout the year, but owing to delayed delivery of tractors, were for several months employed solely as wagons.

Partial results of the above are indicated by the tonnage collected per unit of equipment, viz:

TABLE I—GARBAGE COLLECTION, AKRON, OHIO—COLLECTION PER UNIT OF EQUIPMENT.

	Wagon Service Tons per team per day	Trailer Service Tons per team per day
1919—10 mos.	2.14	...
1920	1.82	...
1921	2.21	3.09

The factors of change in effectiveness of labor and of extension of the area served are also represented in Table I. The day referred to is a nominal 8-hour day which represents possibly 6½ hours' working time.

A comparison of collection costs by trailer is given in Table II.

In Table II the various items denoted as Other Charges are prorated to accord with the numbers of trains involved in collection of the tonnages noted, viz:—an average of 8.99 teams per day in wagon service and 7.39 teams per day in trailer service. Miscellaneous labor includes inspection service and otherwise unapportioned labor. Supervision includes clerical help and overhead at the main office as well as the salary of the Superintendent of Collection. Wages varied from

VIEW OF MACK TRACTOR AND LEE TRAILER TRAIN HAULING GARBAGE FOR THE CITY OF AKRON, OHIO.

A Road Sprayer of Proved Dependability

Mack TRUCKS

Capacities 1½ to 7½ tons. Tractors to 15 tons.

Cressy Road Sprayers are well known the country over as a result of the exceptional service they have been giving for several years. They handle *all* varieties of bituminous road-building material, and their performance with heaviest grades of asphalt is unequalled.

The International Motor Company is the exclusive sales agent for this apparatus which is now installed only on Mack chassis. The sprayer is a complete, independent unit in itself and can be operated without power take-off.

One decided advantage of this apparatus is the fact that the sprayer can be quickly demounted from the Mack chassis and the latter then used with a proper body for general transport service.

We shall be glad to send a booklet to interested parties which describes the Mack-Cressy Road Sprayer.

INTERNATIONAL MOTOR COMPANY
25 Broadway, New York

PERFORMANCE COUNTS

TABLE II—GARBAGE COLLECTION, AKRON, OHIO—COMPARISON OF WAGON AND OF TRAILER COSTS, 1921.

Wagon Collection

312 Days Service: 6,208 Tons.

Teams, $8.99 per day @ $3.55	$ 9,957.32
Wagons, repairs	1,234.79
Harness	1,148.45
Capital charges	1,642.00
Drivers and helpers' wages	28,967.94
Other miscellaneous labor	5,720.00
Charges, small tools	306.00
Power, light, heat	518.00
Miscellaneous sup. and repairs	415.00
Supervision	3,740.00
	$53,649.50

Cost per ton—$8.64.

Trailer Collection.

312 Days Service: 7,138 Tons.

Teams, $7.39 per day @ $3.55	$ 8,185.16
Trailers, repairs	1,038.49
Harness	751.55
Capital charges	6,558.00
Drivers and helpers' wages	24,302.97
Other miscellaneous labor	4,876.48
Charges, small tools	253.09
Power, light and heat	427.64
Miscellaneous sup. and repairs	342.43
Supervision	3,090.00
	$49,825.81

Cost per ton—$6.98.

65 to 80 cents per hour for collectors and from 57 to 65 cents for helpers and reflects reductions effected during the year. The unit team costs are as derived in Table III.

Table IV shows the distribution of expense in operation of the trucks and tractors, delivering garbage. It is self-explanatory.

Summaries from Table II and from Table IV are combined in Table V to give the total cost of collection and delivery.

Truck 67, as reported in Tables IV and V, was used part time to transport garbage and part time as a switch car to spot empty trailers and form trains. Service of the latter nature could be dispensed with at the expense of time required for delivery which locally is kept as low as possible.

Summary

The tractor-trailer method of collection

TABLE III—GARBAGE COLLECTION, AKRON, OHIO—COST OF MAINTAINING TEAMS, 1921.

365 Days—Average Number of Teams, 16.38.

Hay	$3,355.47		
Oats	1,762.50		
Mixed feed	2,259.40		
	$7,377.37	$ 7,377.37	
Straw		810.00	
Barn labor		3,100.00	
Blacksmith—services and supplies		1,868.68	
Veterinary		477.24	
Insurance—liability		305.64	
		$13,938.93	$13,938.93
Horses—capital charges			1,947.00
Land and buildings—capital changes		2,064.10	
Insurance		204.30	
		$2,268.40	2,268.40
Total			$18,154.33

Cost per team per working day, $3.55.
Feed per head per day: Hay, 18.8 lbs.; oats, 10.2 lbs.; mixed feed, 7.3 lbs.

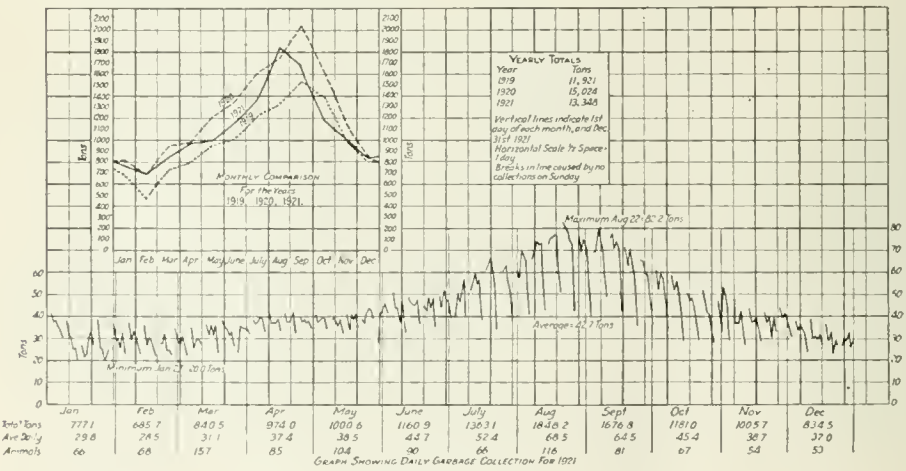

Yearly Totals
Year Tons
1919 11,921
1920 15,024
1921 13,348
Vertical lines indicate 1st day of each month, and Dec 31st 1921
Horizontal Scale 1/8 Space-1 day
Breaks in line caused by no collections on Sunday
Monthly Comparison For the Years 1919, 1920, 1921
Jan Feb Mar Apr May June July Aug Sep Oct Nov Dec
Maximum Aug 20=82.2 Tons
Average=42.7 Tons
Minimum Jan 2=20 Tons
Tons
Jan Feb Mar Apr May June July Aug Sept Oct Nov Dec
Total Tons 777.1 685.7 840.5 974.0 1000.6 1160.9 1363.1 1848.2 1676.8 1645 1181.0 1005.7 834.5
Ave Daily 29.8 24.5 31.1 37.4 38.5 43.7 52.4 68.5 64.5 45.4 38.7 37.0
Animals 66 68 157 85 104 90 66 116 81 67 54 53
Graph Showing Daily Garbage Collection For 1921

DIAGRAM OF GARBAGE COLLECTION STATISTICS FOR AKRON, OHIO, FOR YEAR 1921.

TABLE IV—GARBAGE COLLECTION, AKRON, OHIO—TRUCK AND TRACTOR OPERATION, 1921.

	No. 66 Reo Speed 1921	No. 67 Packard 5T. 1918	No. 67 Packard 5T. 1918 Used as Shuttle-Car to Spot Trailers	No. 68 White 5T. 1920	No. 69 White 5T. 1920	No. 88 Mack 15T. Tractor 1921	No. 89 White5T. Tractor 1921
Performance							
No. of Days Operated	277	115	73	243	257	186	169
No. of Trips	.....	241	.....	459	507	261	248
No. of Tons Carried	.....	1,586	.....	3112	3,167	2,750	2,182
Miles	7,708	1,374	.....	8,331	9,149	4,872	4,761
Ton-miles	.....	14,400	.....	28,250	31,250	25,700	20,950
Costs							
Driver—Wages	1,694.25	676.50	430.25	1,362.00	1,506.00	1,121.75	1,014.00
Helper—Wages	.....	.....	320.00	11.60	.....	950.50	.....
Gasoline and Oil	203.09	752.57	306.92	760.79	993.62	710.27	876.28
Total Operating	1,897.34	1,429.07	1,057.17	2,134.39	2,499.62	2,782.52	609.21
Repair—Wages	60.70	132.70	71.00	643.70	397.60	11.00	61.00
Repairs—Parts	104.05	189.00	151.60	398.38	766.53	24.61	155.39
Total Maintenance	164.75	321.70	222.60	1,042.08	1,164.13	35.61	216.39
Tire Cost	.....	212.00	187.50	781.11	551.45	620.00	411.00
Depreciation	355.00	690.00	557.00	1,213.20	1,213.20	620.00	600.00
Interest @ 5%	71.00	165.00	133.00	337.00	337.00	173.00	166.00
Total Capital Charges	426.00	855.00	690.00	1,550.20	1,550.20	793.00	766.00
Insurance	.....	100.00	78.50	178.50	178.50	156.50	136.50
Total Cost	2,488.09	2,947.77	2,235.77	5,686.28	5,913.90	3,767.63	4,032.38
Units Cost Per Ton Mile	.....	0.205	.....	0.201	0.190	0.147	0.192

TABLE V—GARBAGE COLLECTION, AKRON OHIO—SUMMARY COST OF COLLECTION AND DELIVERY, 1921.

Truck Operation	8,414 tons
Road Maintenance	1,488.10
Truck 67, Table IV	$2,947.77
Truck 68, Table IV	5,686.28
Truck 69, Table IV	5,913.90
Truck 66 Complaints	784.05
	$16,850.10
Delivery cost per ton trucks	$2.00
Collection costs per ton wagons (Table II)	8.64
Total cost per ton—collection and delivery	$10.64
Tractor Operation	4,932 tons
Tractor 88, Table IV	$3,767.63
Tractor 89, Table IV	4,032.38
Truck 67, Table IV	2,235.77
Truck 66 Complaints	460.00
Road maintenance	872.00
	$11,367.78
Delivery cost per ton, tractors	$2.31
Collection costs per ton, trailers (Table II)	6.98
Total cost per ton—collection and delivery	$9.28

has proved effective. Routes formerly contributing but one load per team-day have with trailer service given 2 loads —in some cases 3 loads, though in the last case special and uneconomic labor methods were employed. Costs locally are high. They could he reduced were equipment used more fully, or were it possible to lengthen the time devoted to collection. Road conditions have a considerable influence upon abillty to use trailers.

Akron garbage collection is under the detailed control of B. H. Rawson as Superintendent of Garbage Collection. E. A. Zeisloft, M. Am. Soc. C. E., is Director of Public Service.

MODELS OF MOTORIZED ROAD BUILDING EQUIPMENT EXHIBITED AT CHICAGO ROAD SHOW

A brief descrlptlon of the Kissel road building equipment exhlbited at the Chicago road show was published in the January issue of this magazine; a picture of the exhibit is shown on the title page of this section.

The photograph shows, left to right, the sklp of the concrete mlxer, then the special designed turntable that will turn a loaded truck around ln 10 seconds preparatory to backing up to the mixer; next a replica of one of the special Klssel road builder's trucks which was designed and bullt to carry a 3 cu. yd. body dlvided for 3 batches of 1 cu. yd. each; next the Kissel deslgned and built and patent-

applied-for combination cement hopper and measuring boxes, under which the Kissel truck is driven and receives its properly measured load of cement in less than 5 seconds; next is one of the Kissel designed patented and built combination sand and stone hopper and measuring boxes which dumps properly proportioned loads of sand and stone into the 3-batch body in 5 seconds.

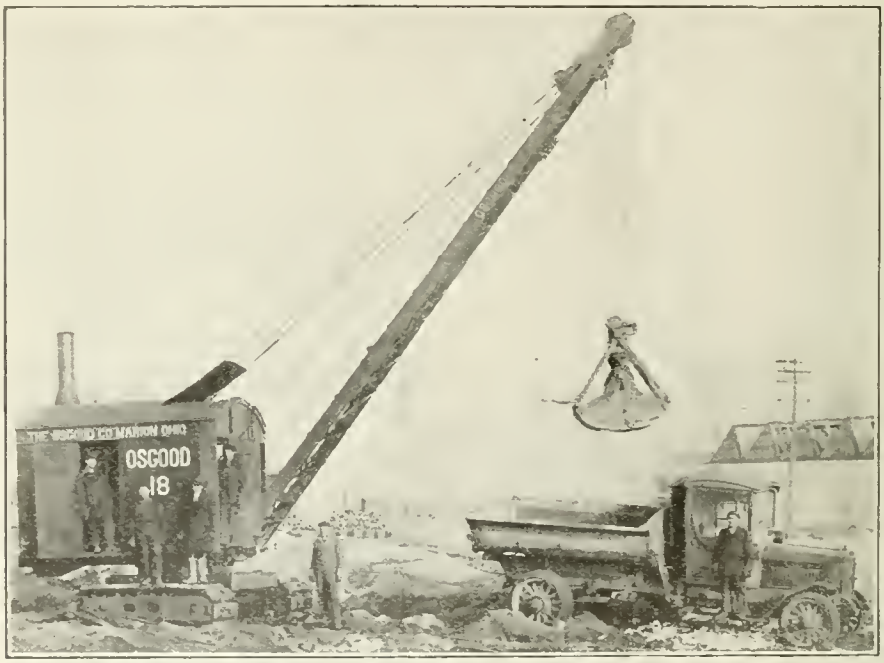
The fact that this miniature layout attracted considerable attention among the old and experienced contractors and road builders at the show proved that they realized how much engineering service has revolutionized the handling and loading of materials, eliminating waste and saving time and labor as compared to the old-fashioned shovel and wheelbarrow methods.

minimum cost. The one big impression the show left on visitors is that road building has been brought down to a systematic and economical basis, which will enable the contractor to lay more road at a lower cost, which means a saving to the public and at the same time the contractor can make more money for himself through the time and labor this motorized equipment saves him.

MOTOR TRUCK NEWS NOTES

12 *Acme 3-Tonners on Building Construction Job.*

When the Hudson Motor Car Company of Detroit, found that new manufacturing facilities and space were needed for building the Essex car, orders were given



ACME 3½-TON DUMP TRUCK OPERATED IN CONJUNCTION WITH OSGOOD CLAMSHELL OUTFIT ON BUILDING EXCAVATION IN DETROIT.

Every visitor was bent on learning how he can save time and labor on his road contracts this year. He also appreciated the fact that the motor truck in connection with the different loading and unloading equipment offers the most economical as well as the quickest way of getting the proper materials to the mixer. It is now possible to keep the mixer running every second throughout the working day and, as every contractor knows, this is what creates maximum footage at

to start construction work at once. Excavating for the foundations was the first step.

How this part of the work was accomplished is shown by the accompanying view illustrating an Osgood 18 clamshell outfit loading a 3½-ton Acme dump truck. This particular 3½-tonner is one of a fleet of 12 Acme trucks which were engaged in the work, the majority of the trucks being furnished by the Kaufman Cartage Co., of Detroit.

In addition to excavating, frozen sand and gravel were taken from stock pile and transported to the sections of the new plant under course of construction.

One Truck Hauls More Than Seven Teams

An interesting comparison has been made in the Oklahoma Highway Bulletin with regard to teams versus motor materials. A road contractor while doing State aid work of hauling crushed stone, employed 7 teams, 7 drivers and one 3½-ton motor truck. The 7 teams had each hauled 3 loads of 1½ yds. per day, a total of 4½ yds. daily. By motor truck he hauled 33 yds. each day. Figuring the cost of each team and driver at $7.25, the total amount was $50.75 per day for 7 teams. The 3½-ton motor truck actually hauled more material each day than 7 teams. The operating expenses of the motor truck figured to $18.40 per day, thereby effecting a daily saving of $32.25. The distance of the haul was 4½ miles each way, or a total of 9 miles.

UNIFORM LEGISLATION AS AFFECTING HIGHWAY TRAFFIC AND HIGHWAY TRANSPORT

By D. C. Fenner, Manager Public Works Department, International Motor Co., 25 Broadway, New York, N. Y.

Any discussion and understanding of uniform legislation as affecting highway traffic and highway transport must be based upon a thorough knowledge of the political structure of the governmental units in which highway traffic and highway transport prevail. This observation seems almost axiomatic and perhaps superfluous, yet too often in voicing the desirability and need for uniform motor vehicle legislation we overlook the fact that motor vehicles in their operation pass through the border lines of and come in turn, under the jurisdiction of municipalities, counties and states.

As for municipal control over highway traffic and highway transport, the kind and degree of such control is dependent either upon the constitutional rights which any state may give to its municipalities, or else upon the laws which states have enacted delegating more or less of their own power on the subject to some or all such municipalities.

While it is true that as a general rule the municipalities may not enact ordinances regulating highway traffic and highway transport along lines in conflict with the provisions of the general state motor vehicle laws, nevertheless, there are numerous important exceptions to this rule. Then, too, there are matters such as the regulation of motor vehicle operation in front of schools, churches, etc., which are matters of local concern and are usually left to the municipalities for regulation.

By a process of elimination, therefore, we arrive at the fact that under present conditions ultimate control in the matter of legislation governing highway traffic and highway transport lies in the legislatures of our various states. It is to these state legislatures, therefore, that in last analysis we must look for that vital and important end—namely, uniformity of motor vehicle laws and uniformity of enforcement.

Uniform legislation does not mean, necessarily, that all states should adopt one and the same law, identical in all their provisions. This might be considered the ideal condition, but from a practical standpoint, it is not necessary.

What is needed, however, is uniformity in those sections of the state laws that deal with definition of terms, traffic regulations, hand signals, qualifications for drivers, size and weight restrictions, obligatory equipment of a vehicle, headlight laws, and disposition of license fees.

Let us take a specific instance to illustrate this point: From the standpoint of the trucking business, which is today assuming very large proportions, no factor is more important than that the various states and their political subdivisions should impose one and the same set of rules and regulations governing the weight limits which such trucks are allowed to carry. A very encouraging procedure in the states of Connecticut and New Jersey restricts the load upon a motor truck to the manufacturer's rated capacity of the vehicle. As the enforcement of this provision will absolutely prevent overloading, it gives the manufacturers a chance to co-operate with the state highway engineers in the design and proper rating of vehicles for the protection of the highways.

The standard specification for a motor truck chassis now contains the allowable gross weight of the chassis and body and load, and also the actual chassis weight. It is possible that these two weights will be the only ones stamped on the truck caution plate by the manufacturer, and that the actual weight of body and the resultant pay load capacity must be stamped on the plate by the owner of the

truck before he can obtain his vehicle license plates. Similarly in the operation of passenger cars there are virtually as many laws on the subject of head lamps and head lighting as there are states in the Union, and no one starting out on a tour is able to be sure that perhaps at any moment or at any place he will not be arrested and severely penalized for the breach of some law or regulation at variance with the ones of his own state with which he is familiar and whose observance has become a matter of habit.

This wide variation in state motor vehicle laws and the unsatisfactory conditions resulting therefrom are greatly aggravated when there are local ordinances additional to or at variance with those laid down in the state laws. Obviously, therefore, the economical operation of a motor vehicle, even within the confines of a state becomes more or less of a gamble.

The remedy for these unsatisfactory conditions lies, of course, in uniformity of state laws having to do with the operation of motor vehicles and uniformity in county or other municipal ordinances. Furthermore, the local ordinances must in every respect conform to the general principles set forth in the uniform state laws. Several movements to accomplish this end have been begun, but the one which has attracted the most support and has gained the greatest headway is that which is now being sponsored and furthered by the Motor Vehicle Conference Committee, an organization composed of representatives from the American Automobile Association, Motor and Accessory Manufacturers' Association, National Automobile Chamber of Commerce, National Automobile Dealers' Association, Rubber Association of America, and the Trailer Association of America. Their views on the matter of uniform state legislation are set forth in a so-called proposed Uniform Motor Vehicle Law and Proposed Uniform Anti-Theft Law. To be sure, these measures contain many features to which persons have taken exception, and it is quite possible to point out sins of commission and omission in their provisions. Nevertheless, their recommendations reflect the views of able and experienced men in matters having to do with highway traffic and highway transport, and it is gratifying to know that many of the recommendations of these two proposed laws are finding their way, if not verbatim, at least in principle, into many of the laws of our states.

More important, however, than this is the fact that the extensive and intensive work that has been done in advocating the proposed Uniform Vehicle Law and Proposed Anti-Theft Law have brought home to the public and their lawmakers the fact that the time has come when uniformity in the regulation of highway traffic and highway transport is absolutely necessary for the safety and convenience of vehicular and pedestrian traffic. In consequence, I bespeak your interest in and strong support for every movement throughout the United States which has this end in view and based upon specific principles and fairness and justice to all concerned.

The foregoing paper was presented at the recent annual meeting of the American Road Builders' Association.

PERSONAL NOTES

H. O. Garman has entered private practice in consulting engineering and the management and operation of public utilities with offices in Indianapolis, Indiana. For more than 14 years Mr. Garman was chief engineer of the Public Service Commission and the Railroad Commission of Indiana, serving under five governors. During this time he valued many hundreds of Indiana properties totaling more than $300,000,000. Mr. Garman is national president of the American Association of Engineers.

President of the National Drainage Congress, Clark E. Jacoby, has appointed the following committee as members of the National Legislative Committee, which will appear before the various Congressional Committees in behalf of National Reclamation Laws for Swamp, Cut-over and Overflowed lands: F. H. Newell, Chairman, 1839 Phelps Place, N. W., Washington, D. C.; Mark W. Potter, Interstate Commerce Commission, Washington; Hon. John H. Small, 940 Munsey Bldg., Washington, D. C.; Col. Joseph Hyde Pratt, Chapel Hill, N. C.; Edgar A. Rossiter, Civil Engineer, Chicago, Ill.

Mr. Leo Hudson, Assoc. M. Am. Soc. C. E., and Mr. John P. Myron, M. Am. Soc. C. E., have formed a partnership for the practice of engineering under the firm name of Hudson & Myron, Engineers, with offices at 808-810 Wabash Building, Pittsburgh, Pa. Mr. Hudson has been in private practice for the last 15 years, principally on waterworks, sewerage, power plants, valuations and rates. Mr. Myron, until recently, was for a period of over 17 years, connected with the Pittsburgh

Filter & Engineering Company as Secretary and Engineer.

R. F. Kelker, Jr., M. D. Gates and C. E. DeLeuw, announced the dissolution of the firm of Kelker, Gates & DeLeuw, of Chicago, effective Jan. 1, 1922. The new firm of Kelker, DeLeuw & Co., has taken over all current contracts except the Platte Valley Drainage District of Worth County, Mo., and the Upper Salt Creek Drainage District of Logan County, Ill., which will be handled by Mr. Gates. Kelker, DeLeuw & Co., will engage in general municipal and sanitary engineering, with offices in the Conway Building, Chicago.

Harry P. Grier, formerly of Statesville, N. C., and formerly County Engineer for Iredell and Alexander Counties, N. C., has been appointed District Engineer for the Asphalt Association, with headquarters in Raleigh, N. C. He will aid highway engineers and officials in working out their paving problems wherever asphalt is a factor.

George L. Sawyer, formerly Sales Manager of material handling machinery for the Barber-Greene Co., of Aurora, Ill., has been appointed to represent the Universal Crane Co., in the New York field, with offices at Allied Machinery Center, 141 Center St., New York City.

Mr. C. Gray, for some time Acting Chief Engineer of the Indiana State Highway Commission, has been appointed Chief Engineer.

Following the death of Lewis S. Sadler, Highway Commissioner of Pennsylvania, Governor Sproul announced that George H. Biles, assistant Highway Commissioner, will direct the affairs of the Pennsylvania State Highway Department.

Commissioner Biles has been with the State Highway Department since June, 1905, when he was appointed Chief Draftsman. Prior to that time he was associated for several years with the Philadelphia Department of Public Works. In June, 1906, he was named Division Engineer in charge of the central and a portion of the eastern counties of Pennsylvania, and conducted for the State Highway Department some of the first experiments in bituminous road materials. As Division Engineer he supervised the construction of the famous Lewistown Narrows model road, the first highway built under the Sproul Highway Act. He also built the river drive out of the city of Harrisburg. In December, 1912, Mr. Biles was appointed assistant to the Chief Engineer and in 1913 he became Maintenance Engineer, organizing the Maintenance Division and assuming direct charge of all maintenance on State Highways and State-aid roads. In June, 1915, he was named Second Deputy State Highway Commissioner, and in 1918, in addition to his supervision of maintenance, was placed in charge of all construction and administrative work. When Lewis S. Sadler became State Highway Commissioner, Mr. Biles was named Assistant Highway Commissioner. Plans of the State Highway department for the 1922 construction season, as tentatively decided upon during the lifetime of the late Highway Commissioner Lewis S. Sadler, will be carried out.

The United States Cast Iron Pipe & Foundry Co., has opened a new office at 811 Dixie Terminal Bldg., Cincinnati, O. Mr. P. T. Laws, Assistant Works Manager, will make this point his headquarters. Sales from this office will be in charge of Mr. Harold G. Henderson.

A HANDY FORE-SIGHT ON STREET WORK

By M. Y. Crowdus, City Engineering Dept., City Hall, Nashville, Tenn.

When staking out curbing on streets the transit is very often so close to the car tracks that the vibration of the passing street cars throws the instrument out of alignment. This necessitates constant reference to a fore-sight, and fore-sights on city streets are difficult to establish, and a nail, or tack or pencil is quickly knocked down by passing automobiles.

A sturdy, dependable fore-sight may be constructed from a square or triangular shaped bar of steel, 12 ins. long, and 2 ins. thick, its faces painted white with red division lines spaced 0.01 ft.

The transitman may at any time place this "fore-sight" 100 ft. or so ahead of his instrument, for constant reference. Automobiles will not greatly disturb the heavy bar, especially if of triangular shape, and should a passing car run over the bar, the transitman has only to "pick up" another red line for a new fore-sight.

LICENSING ENGINEERS IN UTAH

The Legislative Committee of the Ogden Chapter of the American Association of Engineers, in conjunction with other chapters and engineering organizations of the State of Utah, has taken action toward having bills introduced at the next Legislature for civil service, zoning, and licensing of engineers in Utah.

KENTUCKY ROCK Kyrock ASPHALT

Striking Recognition of Merit

ALTHOUGH the presence of vast deposits of natural rock asphalt in Western Kentucky has been known for a quarter of a century, it was only a little over three year ago that engineers and capital braved the difficulties of this rugged country, and attempted its production on a large scale.

Since that time, some three and one-half million square yards of Kentucky Rock Asphalt pavement has been laid.

Ten states have included Kentucky Rock Asphalt in their standard specifications.

The United States Bureau of Roads has repeatedly approved this natural paving material for federal aid on the heaviest traffic roads.

In 1920 Kentucky Rock Asphalt was used on state and county roads and for city streets, drives and maintenance, in thirteen states.

Kentucky Rock Asphalt is winning on real merit. Its use increases just as rapidly as the production justifies introduction into new fields.

* * * *

Kentucky Rock Asphalt is a perfect asphalt mix. The mineral aggregate is pure angular silica sand, each grain 100 per cent coated with live bitumen.

The material is shipped ready to lay cold on any type of base sufficient to carry the traffic.

No mixing, heating or other special equipment, no expert workmen are required to build a successful pavement.

Kentucky Rock Asphalt makes a pavement equal in every respect, and superior in many ways, to the most successful sheet asphalt. It is noiseless, dustless and resilient. It does not crack, roll, buckle or bleed.

The simplicity of Kentucky Rock Asphalt construction, due to the fact that it may be laid cold without special binder course or curb, makes it possible to build the highest type asphalt highways, where the cost and physical difficulties of laying other pavements would be prohibitive. In cases where the old road will serve as a base, Kentucky Rock Asphalt means a still greater saving.

* * * *

Kentucky Rock Asphalt was formed by nature in a process requiring untold centuries. It is incapable of experiment. Either it is or is not a successful pavement. Kentucky Rock Asphalt highways which have stood up under the heaviest traffic for years, have more than proven its unusual merit.

Each ton of Kentucky Rock Asphalt which leaves the pulverizing mills is laboratory tested to insure absolute uniformity. Material shipped today is the same as that used on the famous Camp Knox road at Louisville, the Nelson Avenue road in Ohio, the Midland Trail in Kentucky and other highways which have withstood heavy traffic for year.

Laid on an adequate base, Kentucky Rock Asphalt always gives maximum results.

Our new booklet gives the complete story of Kentucky Rock Asphalt and descriptions of many old roads. Write for Booklet E.

Kentucky Rock Asphalt Company

INCORPORATED

711-718 Marion E. Taylor Bldg. LOUISVILLE, KY.

EDITORIALS

WHAT IS PROFESSIONAL ENGINEERING?

Many who have never been greatly interested in the attempts to define engineering are now conscious of the need for at least a common understanding of the meaning of the term "professional engineering" even if a satisfactory definition of "engineering" cannot be formulated. Of course there have been made many attempt to define enginering. At least one such definition has been current for many years, that of Treadgold, and it has been quoted innumerable times, but it is so broad that it may fairly be said to include farmers, miners, and perhaps others, as well as engineers. This has been the great difficulty in attempting to define "engineer" and "engineering;" namely, if the definition is made broad enough to include all branches of engineering, and at the same time is kept short enough to be at all useful, it comes very close to including everybody and everything else besides "engineers" and "engineering."

Now that state boards are licensing men to practice "professional engineering," however, one must give serious thought to the meaning of that term, no matter how fully convinced he may be of the futility of trying to define the term so it will mean the same thing to the boards, the engineers and the general public. In fact, the tendency on the part of some boards to place a narrow interpretation on the term is the very thing which is creating serious friction between the boards and the men who have considered themselves engineers and who have been so taken and accepted by the public.

It may be doubted if it is feasible to formulate a definition of professional enginering which will be generally acceptable unless it is made so involved and so full of qualifying clauses that it would not be readily useful. If this is true one must rely on description, or accepted usage, in preference to precise definition.

We believe it is possible for the boards and the engineers to reach an understanding in the interpretation of license laws, and such an understanding is greatly desired by all, if the boards will accept, within limits perhaps, the generally accepted usage of the term "professional engineering."

Now what do we all mean when we speak of a "professional engineer." Just this: we mean to differentiate between the man who drives a locomotive, or operates a hoisting or other form of stationary engine, and the man who applies the principles of engineering science as it is taught in the recognized engineering courses of study in our schools and colleges. It was not until unsuccessful attempts had been made to get the public to use such terms as "engineman" and "engine-driver" that some genius thought of using the term "professional engineer" to prevent confusion in the popular mind. The young man who had graduated from an engineering college and who made his living by following the line of work for which he had been schooled did not like, for a variety of reasons, to be asked: "What road do you run on?" We insist, in all seriousness, that it was the accumulation of a multitude of such misunderstandings, each perhaps trivial in itself, which lead to the adoption of the term "professional engineer," simply and solely to remove a natural cause for confusion in the popular mind.

Stated in this way the subject loses much of its mystery and that, of course, is what we desire to accomplish in this discussion. We believe we have described, if we have not defined, the generally accepted meaning of the term "professional engineering" and have indicated the broad common ground of complete mutual understanding on which we know the boards and the engineers so greatly desire to come together.

We believe the boards should adopt the meaning of "professional engineering" here described, "within certain limits," perhaps. What limits? Limits as to responsibility, age, experience, ability, etc. In other words, lines must be drawn here as elsewhere and the question reduces itself to this: "Where shall we draw the line; when does a man cease being a clerk in an engineer's office and become an engineer?" Our criticism of the boards is that they have placed the line much too high, over the heads, in fact,

of the majority. While it is true that the older men are the brain of the profession, and are honored by all as such, it is equally true that the younger men are its bone and sinew, yes, its very life blood; each would be nearly useless without the other.

The state admits to the practice of law and medicine many who are very far behind the leaders in those professions in ability and it must do the same with engineers. All engineers are not first class engineers, but many who are not are decidedly useful citizens and are deserving of recognition of their professional status by the state. To withhold a license is to brand as incompetent, and the vast majority of engineers are decidedly competent.

If the line is placed so high that only a small minority of men in engineering work are recognized by the state as "professional engineers," while the great majority of them are virtually rated, by inference, as clerks, it is only natural that the reaction on the majority will be most unfortunate to them, to the profession as a whole, and to the public, for it inevitably will drive them into organized movements having some of the characteristics of trade unionism of which engineers do not approve. Thus, licensing which might elevate the profession may debase it. In seeking to accomplish too much at the outset the boards may do more harm than good.

THE 3 IN. PAVING BRICK

In discussing the standardized paving brick, in an article to be found in this issue, the author expresses doubt as to the ultimate economy and serviceability of the 3-in. brick. Of course only time will tell whether or not brick of this depth may safely be specified by the careful engineer. Not enough experience has yet been had to warrant anything like final judgment in the matter. It may be that the fears of the author, for whose views the profession rightly entertains great respect, may prove well founded with reference to this brick. Of course if it cannot stand up under service requirements it will be abandoned in favor of brick of greater depth.

We have been disposed to look upon the shallow brick with favor; at least we feel that it is deserving of a thorough trial. It may be that we are slightly prejudiced in its favor for we see in this attempt to economize in material the very essence of good engineering. Of course there is such a thing as cutting too fine: but that is the question which time alone can answer.

Meanwhile, those interested in the subject will note that the shallow brick is sponsored by some men who have devoted much study to the subject; men of great experience and wide observation. As our readers know, the present eleven standard varieties of paving brick provide for 3, 3½ or 4-inch wearing surfaces with a view of providing brick pavements suitable for varying traffic requirements.

The straight wire cut brick of 3 in. depth, asphalt filled, has its staunch defenders. In fact, since 1917 this variety of brick has risen from approximately 5 per cent of all brick shipped to approximately 43 per cent, and the proportion is still on the increase.

STREET LIGHTING PROGRESS IN 18 YEARS.

We have remarked in this department, on various occasions, that municipal engineering is steadily advancing, although the change from month to month is so slight that it is readily assimilated by the engineer who cares to keep up to date. This truth becomes very evident when we go back from ten to twenty years and note the great changes which have occurred in municipal engineering practice since that time.

We are indebted to an engineer reader for an unusually forceful illustration of the progress in street lighting since the year 1904. In that year the clerk of an Iowa town wrote to the clerk of a Minnesota town:

"We have your inquiry in regard to our experience with gas lighting plants. Our experience with acetylene gas was a sad one as follows: Constructed and completed in September, froze up in October, exploded in January; two funerals three days later. Was constructed and owned by Bingville people under a franchise granted. If you think you want acetylene gas, you can get piping, remnants of machinery and buildings and perhaps some tombstones by applying to the Blank Construction Co. of Bingville. I think you can get some plate glass also, as they had to furnish this town with several hundred dollars' worth and perhaps have some on hand for future use."

IMPORTANCE OF SURFACE FINISH AND METHODS OF CONTROL IN PAVEMENT CONSTRUCTION

By H. Eltinge Breed, Consulting Engineer, 507 Fifth Ave., New York, N. Y.

Apparently a strong mental tendency is to disregard the obvious and seek the remote. Perhaps this is because the obvious is often an aggregation of trifles, while the remote may be striking, stupendous. Certain it is that almost any more obscure cause may be heard given for the success or failure of any road, than the simple one of surface finish. Yet, I believe that in the concrete road economically designed, the life of the pavement depends as much upon the surface finish as upon any other factor.

We know now that impact is the great cause of destruction in our pavements. Impact is the bumping or banging of one object upon another. As I roll a smooth cylinder along a smooth table there is practically no impact but let ridges appear in the table, and as the cylinder bumps along over them, you get a series of impacts that, if the cylinder be heavy enough and rolled often enough, will soon wear out the surface and damage the structure.

That is analogous to what is happening to our roads. If the wheels of vehicles are smooth and the pavement surface is smooth there is no damaging impact from traffic. The road lives even though it be weak in proportion to the volume and weight of traffic it must carry. But let surface irregularities develop, and no matter how strongly built, the whole pavement soon shows the effects of wear. We build our roads on an average to withstand a pressure of 800 lbs. per lineal inch width of tire. Yet, if an unevenness in surface of only ¼-in. occurs, the impact of one rear wheel of a 5-ton truck may exert an impact pressure upon the road of 20,000 lbs. Under such pressure, the unevenness becomes a depression whose edges spall and break, causing further impacts and more depressions until the pavement is badly damaged.

In order to lessen impact we must get and keep smooth surfaces. How can we do it? Close scrutiny of work and infinite attention to detail are essential. Then there are certain general remedies suggested by the general causes of unevenness, specific remedies being tried by different states or on different jobs, and different methods of work and machinery.

Causes of Unevenness in Pavement Surface

There are five general causes of unevenness in the pavement surface:

1. Foreign materials in the aggregate, which, failing to amalgamate are ousted, leaving holes and depressions.

2. Non-uniform aggregates, which cause inequalities in wearing resistance to traffic, and subsequent depressions in the weaker places.

3. Poor workmanship in striking off and finishing.

4. Cracks, longitudinal and transverse, due to frost action, changes of temperature or unequal bearing power in the subsoil.

5. Uneven joints, perhaps the most common cause of surface trouble, due often to the piling up of joint material or to difference in elevation of slab surface.

Remedies for Surface Unevenness

The general remedies for surface unevenness are as obvious as the unevenness itself, and therefore, perhaps, as often neglected—strict specifications exacting good material and good workmanship. More and more we are getting these on paper. The problem is their application to the job, because there is where the human element enters. How solve the personal equation between engineer and contractor? I wish that sometime we might have fuller discussion on this point. The answer is at once made that the relationship should be one of co-operation and mutual endeavor toward a common end—the best possible road. But as long as private profit outdistances social welfare as an aim in our economic life, just so long are we often going to have the contractor trying to get all he can out of a job, while the engineer is trying to make him put all he can into it. So, sometimes the letter of the specifications is violated, and frequently their spirit. When all engineers know their job so well that they can show contractors easier and better methods of doing their work, and when all contractors regard highway work as a legitimate industry and not a financial gamble, then we shall have that adherence to specifications that will insure good work and smooth surfaces.

Three other general methods of preserving good surface finish, once it is obtained, are the use of steel reinforcement, the division of the road longitudinally, and the wider spacing of joints with the use of dowels.

Advantages of Steel Reinforcement

Theadvantages of steel reinforcement are that it gives the road greater bearing power and greater resistance to frost action and that it offsets irregularities and weakness in the subsoil. By helping to preserve the integrity of the pavement, it minimizes any tendency toward cracking, which is of course a cause of surface unevenness.

The division of the road longitudinally increases its beam strength about fourfold. Observation reveals that longitudinal cracks are not found in slabs 9 and 10 ft. wide, though we have all encountered them in slabs beyond that width. The reason for this difference is still conjectural, but until it is ascertained we would do well to be guided by results hitherto obtained.

Use of Longer Slabs

Transverse joints being a prolific source of trouble, it is well to diminish their number as far as possible through the use of the longer slab. This wider spacing of joints becomes feasible through the use of steel reinforcement to meet the temperature stresses of the slab. The use of dowels gives stability to the joints and holds the surface even. The submergence of joints an inch below the surface has proven unsatisfactory. Devised at first to secure a smooth surface and permit the use of a finishing machine, it seemed admirable until subsequent expansion crowded and crushed the concrete above the joint material, leaving a badly ravelled and spalled joint. The best method that I have found of making a joint is to submerge the joint material until after the screed or finishing machine has passed over it; then to lift the joint material slightly above the surface with long fingered tongs; then to finish the joint with the split float or split roller, rounding the concrete next to the joint material with an edging tool.

Specific application of these general principles is found in the requirements of such states as Delaware, Pennsylvania and New York. In these states, and in others, the specifications exact good workmanship by allowing a maximum of only ¼-in. depression in 10 ft. of pavement tested with a straight edge. The use of the straight edge on green concrete indicates depressions to be rectified and insures good results. These states specify materials with such precision as almost certainly to preclude the use of foreign materials in the aggregate or of non-uniform aggregates. They design the roads so as to minimize the danger of movement in the slab and resulting cracks. And they give special attention to the placing of joints and to the suitability of the machinery in use.

All of these precautions were taken on the road built last summer in Old Bennington, Vermont, by the Fred T. Ley Co., and so far not the slightest indication of any surface unevenness has appeared on it. This tends to support my belief that we are going to be able to build roads within necessary financial limits that under the traffic permitted by law will be practically indestructible.

Belting and Rolling the Surface

The actual method of finishing is of course important in securing a smooth surface. Some road builders prefer to use the finishing machine with the roller and belt. It is essential that the roller be light. A too-heavy roller pushes the crown out of the pavement, and spoils the surface. Most specifications call for a weight of from 12 to 15 lbs. per foot length. Some builders omit the roller, using only the machine. My own experience indicates that the roller helps. One advantage of the finishing machine is that a dryer concrete can be used with it, which gives greater strength to the pavement. It also gives more uniform results than can be obtained with a green gang, and seems in general more foolproof than the hand method. Still, many prefer to strike off with the hand screed, using the roller and belt. This has the advantage of making one less piece of plant to get out of order and where a heavy screed is used in the hands of competent workmen it gives as smooth a finish as the finishing machine.

With either method the board belt gives unquestionably the best finish. The bow belt, however, can give good results. Proper belting takes off not only the water, but also the clay loam, laitance, etc., that tend to form scale on the surface.

I have tried in this paper to call attention only the salient features in securing surface smoothness in the hope that a hasty summary might help to bring practice and theory closer together so that theory might receive fresh impetus to discover the something new on the subject that I have not been able to find and tell you.

The foregoing paper by Mr. Breed was presented at the recent annual meeting of the American Road Builders' Association.

HIGHWAY ENGINEER INDORSES TYPE OF ROAD DRAINAGE RECOMMENDED BY DRAINAGE EXPERT

To the Editor:

I have before me a copy of your magazine for January, 1922, namely, Vol. LXII, No. 1, in which is an article by Edgar A. Rossiter, Consulting Civil Engineer of Chicago, entitled, "A Drainage Expert's Ideas on Highway Construction."

I cannot agree with Major Rossiter in all of the thoughts which he expresses, but desire to state that from my personal experience covering 8 eight years in the construction and maintenance of improved state highways, I can, without reservation, substantiate his drainage design as shown by Fig. 3 on page 12, in the said issue of your magazine.

As the Major states, "Our technical papers, books and magazines for the last 10 years have been filled with articles relative to highway construction . . ." "To the layman man yof these articles are but a pitiful confession of ignorance of highway construction by their authors."

As every student of highway work, even a superficial one, knows, these articles have passed from grave to gay and from the sublime to the ridiculous. One article may state that we need no drainage, and the next that it is the most important thing in road construction; another article makes the dogmatic statement that clay is a fluid; another that all the roads in New York State are built on gravel subsoil, etc., etc.; but, amongst this great number of articles there can be found many which are instructive, and the great trouble is to separate the wheat from the chaff.

Sometimes I have felt almost as Major Rossiter must have felt when he wrote this article, namely, that we were groping blindly in the dark, believing that a truth was within our reach but not knowing where to grasp in order to obtain it. Nevertheless, when I have considered that the integrity of our roads in this northern climate depends as much or more upon the handling of a force of which we know little or nothing, as on any other factor, it seems as if we had accomplished something of real value when I observe the road construction of the past 10 or 20 years.

The unknown force referred to is that occasioned by the freezing and thawing of our subgrades, and it is believed that this can never be determined with any degree of accuracy except through intelligent observation over a long period of time over various classes of soil and various classes of road pavement. The various experiments which have been made and which at present are being made upon so-called typical sections of roadway, it is believed, will constitute or produce nothing excepting some data upon which opinions might be formed, and that they will not produce actual bona fide facts from which the road builder can say: "Here you shall put this type of road, and there you shall put that type of road," knowing that no other type should be used in these places.

Major Rossiter as a hydraulic engineer, has shown in the aforementioned Fig. 3, exactly the type of drainage which has been developed by work done under my supervision during the past 7 or 8 years. Drainage of this type was placed in a road near the Canadian line 6 years ago. Prior to the placing of this drainage, this road "broke up" every spring, and in fact, actually looked as if a rooter plow had been run through the macadam. What we did was to roll the old macadam after the frost was out of the road, put on a new 3-in. macadam top with a bituminous binder, clean out our ditches and lay a line of tile in exactly the same position as shown on said Fig. 3, on that side of the road from which the sub-soil waters entered, as at that time we did not take into consideration the actual run-off from the road itself, of which Major Rossiter's article speaks.

Since that time this road has never failed. Moreover, since that time several pieces of road have been similarly fixed, and at the present time, I have a contract under way upon which 18,000 lin. ft. of exactly this kind of drainage is being placed, and in the past 4 or 5 years we have been fully aware that a large portion of the so-called "blow-ups" on our roads were caused by the freezing of water which soaked down through the road itself and not because of water which came in from the sides. This is proved by observation of several conditions during the past years, a few of which are as follows:

These blow-ups have occurred on roads where the ditch and culvert drainage was in good condition; they have occurred as often on the side hill, namely, the middle of a hill grade, as at the summit of the grade or at its base, or along the adjacent flat lands; they have occurred at times

on fills of several feet in height, as well as in cuts of varying depths. Therefore, we have been forced to the conclusion that good ditches are not sufficient, that our surface must be kept watertight, and that where there is danger from the run-off from the pavement itself seeping into the subgrade, it must be taken care of in the manner shown on said Fig. 3.

Do not think from the foregoing that we put in tile on all of our roads in the manner shown, or that we put it in every time that we are in doubt as to whether or not it is needed. We are designing our roads the best we can, all conditions considered, and there are many conditions which enter state highway work, some of which take precedence at times over the purely engineering features, and if Major Rossiter would get into the game as a state official, he would realize some of these conditions as well as those of us who are engaged therein.

Will you kindly thank Major Rossiter for this article, as I know there is far more good than bad in it, and am glad to have seen a copy of it.

Very truly yours,

T. M. RIPLEY, Division Engineer.

New York Commission of Highways, St. Ann Federation Bldg., Hornell, N. Y., Jan. 31, 1922.

ADMINISTERING ENGINEERS' LICENSE LAWS

To the Editor:

I was very much interested in your editorial on page 1 of the January issue entitled, "Administering Engineers' License Laws."

There is another aspect to this question which, while vitally serious, seems to be ignored by the engineering profession. This is the attempt by a license law, or its interpreters and administrators, to establish the practice of engineering as a business and not strictly as a profession.

Take a case in point with which I am fairly familiar. A law to license land surveyors (a minor division of civil and municipal engineering) became effective on January 1, 1920, in Cook County, Ill., which includes Chicago. This law applies to this *one* county in the State. The balance of the State remains "unprotected." This law was engineered quietly without apparent knowledge on the part of leading engineering societies. At the time the law became operative, a number of the local municipal engineers filed application for license, as per provision in the law, showing in all cases from 5 to 40 years' experience in surveying in Chicago—Cook County.

These men do the careful, disinterested surveying in laying out street and alley lines and defining property lines, in securing footage and preparing plots for condemnation in widening or extending streets, etc. Could they get a license, based on their practical, continuous professional experience? No! The Board ruled that one must be in *private business* on or before that date (Jan. 1, 1920), to be entitled to a license. Many incompetent men opened offices and were licensed without examination, while the truly competent surveyors who had worked for the city, or the great utility corporations, and, in many cases through their ability had advanced to higher classifications in engineering, were denied licenses; not because of their ability, which apparently was not given any weight, but because they were not in individual private practice. In other words, the administrators of the law seek to limit competition for their own advantage. Of course, a surveyor, or municipal engineer *employed* by the municipality, sanitary district, county and public corporations (on their own property) can work in his "official capacity" as a surveyor. If he loses his job apparently he cannot work as a surveyor. The apparently serious feature is that competent men, well qualified men, have no legal or professional standing.

Thus you have the peculiar spectacle of the more competent men, doing professional work, being unlicensed, while the incompetent, the least experienced, the out-of-date, disconraged class, are licensed and legally granted leadership (?) and a degree of unearned respectability over their more fortunate (or is it unfortunate) brothers!

Just such things as this discourage licensing and make the engineering profession ridiculous before the eyes of the public. I believe your publication could confer lasting benefit on the profession by investigating the various laws and their administration and secure their repeal or sensible modification.

A license law should be based on a man's ability in his chosen line. His education or employer has nothing to do with it. The present danger lies in extending this idea of malpractice or administration to laws yet (?) to come.

Very truly yours,

A CHICAGO ENGINEER.

Chicago, Ill., Jan. 27, 1922.

SCIENTIFIC ROAD BUILDING IN ILLINOIS

Illinois not only has attained a leading place among the states of the union as a road-building state, but it also has attained leadership in the matter of the scientific design and construction of paved trunk line highways.

In 1921 only one state—Pennsylvania—led Illinois in the construction of modern high type pavements; Pennsylvania having built 670 miles and Illinois 412 miles. New York was next with 347 miles, followed closely by Wisconsin with 340 miles. For 1922 Illinois has adopted the slogan of 1,000 additional miles of road paved and ready for traffic.

In a paper read before the American Road Builders' Association, in convention at Chicago, Clifford Older, chief highway engineer of the Department of Public Works and Buildings of Illinois, outlined Illinois' claim for leadership in matters relating to the scientific design of trunk line pavements.

Bates Experimental Road

With the large amount of money for road construction that had been made available by the passage of the Sixty Million Dollar Road Bond Issue Act, it was considered of extreme importance that "guess work" be eliminated from pavement design. With this in mind the construction of an experimental road near Springfield was undertaken. This is known as the Bates Experimental Road. It was started in 1920 and finished during the summer of 1921.

The Bates Road is about two miles in length, and includes 63 sections, each approximately 200 ft. long and representing all types of modern pavements; several thicknesses of each type being used so that when trucks are operated over the road with increasing loads, the capacity of each section, measured in terms of weight and numbers of trucks, will be plainly obvious.

Brief Outline of Research Work Carried On

Although the truck loading of this road has not yet taken place, the research work carried out by the department thus far indicates clearly, according to Mr. Older, just what may be expected of each type and each thickness. Already, many matters of great interest to engineers and of vital importance to the taxpayers and the road users, which have not heretofore been known, have been determined. For example: Heretofore it has been assumed that by means of tile drains the foundation soil under a pavement may be kept dry. Mr. Older brings out the fact that the Bates Road test shows that tile drains are practically useless as far as keeping the foundation soil dry is concerned, although they may prevent excessive "heaving" of the slab because of frost action. A surprising fact brought out by Mr. Older was that the amount of water in the soil, under a road slab may be as high as 40 per cent of the weight of the dry soil, and this in spite of the fact that tile drains may be placed along each edge of the pavement. In this paper it was further stated that rigid pavements, such as concrete and brick on a concrete base, are not fixed and rigid as the casual observer commonly believes, but are in constant motion even though no wagons or trucks may be moved over them. Such pavements lengthen and shorten due to changes in temperature; they stretch and shrink laterally due to the same causes. More important to the engineer, however, is the fact discovered by the Illinois Division of Highways that the unequal heating and cooling of the top as compared with the bottom surface of the pavement as the temperature of the air changes, causes the pavement slab to curl up at the edges at night to such an extent as to lift the edges entirely off the foundation soil. In the day time the reverse is true, when the center of the pavement is likely to be lifted entirely free from the foundation. The importance of this action may be appreciated when it is known that the edge of a concrete slab 7 ins. thick may lift above the foundation in extreme cases as much as ¼ in. at night. Obviously, pavement slabs must be designated for this condition.

As a result of these investigations, Mr. Older believes that Illinois has been enabled to design pavements having practically double the strength of the designs heretofore used, and yet at a saving in cost of approximately $1,500 per mile.

Another matter of interest brought out in this paper relates to the breaking down of concrete slabs under repeated loads, due to a fatigue of the slab. This may be better understood by an illustration. The Department has found that a truck wheel carrying a total weight of about 5 tons may pass along the edge of a 7-in. concrete pavement of the ordinary design once or twice without breaking the pave-

ment; yet if the same wheel passes along the edge from 10 to 50 times, the edge of the pavement breaks down in many places. Loads on such a pavement would have to be reduced to 2½ tons in order that trucks having wheel loads of this magnitude might be carried indefinitely by the pavement. Further, investigations have shown that a pavement may carry loads equal to 60 or 70 per cent of the critical loads only a few thousand times without breaking—in other words, in order to provide a reasonable factor of safety a pavement must not be loaded in excess of one-third of its apparent strength without danger of its failing in a comparatively short time.

Amount of Expenditure in Experimental Road Justified

Although the construction of the Bates road has involved a considerable expenditure of State funds this fund has already been returned many times in reduced construction costs and the knowledge gained as regards the construction of better roads. While the saving effected in the expenditure of the Sixty Million Dollar Road Fund will amount to a considerable sum because of the Bates experiment, yet this item is of far less importance than the saving of maintenance expense effected by the construction of the best pavements engineering can devise.

As stated in the beginning, it will eliminate the "guess work" from pavement design.

RECENT DEVELOPMENTS IN PAVEMENT CONSTRUCTION DETAILS

By Charles M. Upham, Chief Engineer, North Carolina State Highway Commission, Commercial National Bank Bldg., Raleigh, North Carolina.

The past two years seem notable in the fact that no great changes have been brought about or new methods introduced in the construction of modern type pavements, but rather the energy of progress has been expended in the development of many details which had previously proven themselves hindrances in economical road construction. With the present character of road materials, and the mechanical devices now in use, the types of pavements seem to have established themselves and to have settled within distinctive limits.

Half-Width Roads

The construction of half-width roads can hardly be called recent. It has been found that this method may be followed and satisfactory results obtained. This development of road construction releases the traffic from the long rough detours, which are very often present in road construction, and makes the road available for traffic during construction. This method has been utilized satisfactorily in the case of the construction of the bituminous type pavements, and, in a few instances, it has brought about good results in the construction of water-bound macadam, but it is generally used in concrete road construction. Where this road is constructed for a heavy duty road, it is very often heavily reinforced, and each half of the road is kept separate and apart from the other half, so that the complete pavement really consists of two strips of pavement laid side by side. In this method of construction the heavy reinforcement is longitudinal, and, on account of the center line joint taking up the vertical movement of the pavement, thus eliminating any longitudinal cracking, and the transverse cracking is decreased to a minimum, even in the part of the country that is subjected to heavy frost.

In other instances tie rods have been used to tie the two strips of pavement together. This method, however, introduces difficult details in construction, and at the present time has shown no particular advantage over the other. The practical advantage of the longitudinal joint is in the fact that the construction joint is easily maintained, and is not especially objectionable in appearance, while a jagged, irregular longitudinal crack is difficult to maintain, and is very unsightly in appearance.

In some states this longitudinal or center line construction joint is provided, even though the pavement is constructed in one operation, the advantage being the same as when the pavement is constructed in two sections.

Building Hard Shoulders on Old Macadam

Another recent development in road surface is the widening out and the reclaiming of old macadam roads by building a strip of hard surface pavement on each side of the macadam. On either side of the old macadam road varying from 5 to 10 ft. in width, there is placed a strip of concrete pavement from 9 to 10 ft. wide; these strips being sometimes reinforced. This method furnishes a comparatively wide pavement, and renders useful a road which would otherwise be

too narrow to be of any service to traffic.

Tendency to Increase Amount of Reinforcement in Concrete Roads

Another development in road surfacing has been the general tendency to increase the amount of reinforcement in concrete roads.

Only a short time ago many engineers were reinforcing their roads with metal wiring, approximately 25 to 27 lbs. to 100 square feet. At the present time it is a common practice to use approximately three times this amount, with the tendency to still further increase the weight of material. The Specifications of North Carolina for 1922 will undoubtedly call for metal amounting to nearly 100 lbs. for each 100 sq. ft. This has effected a large economical advantage in the cost of roads, which has brought a reinforced concrete surface to the point where the changes in reinforcements are not left to the imagination. The present price of steel has made it possible to create considerable saving in dollars by the construction of thinner concrete pavements. Where reinforcement has been used in most cases the road has been constructed of a universal thickness, this also affording a considerable saving of concrete.

Batch Transfer Method

Much progress has been made in the methods of laying concrete pavements, the tendency being not to allow concrete materials to be placed on the subgrade. The batch transfer method is now becoming a standard form of construction. This method has proven economical, in most instances, and capable of large yardage. There have been many combinations of this method, such as hauling by industrial railway with the batch boxes carried upon the railway cars; as well as the motor truck hauling with the batch boxes loaded on the trucks; and the trucks being provided with batch compartments. In some instances the batches have been hauled a portion of the distance by trucks and transferred to industrial railway. This has proven a very economical combination in many cases.

Central Mixing Plants

The central mixing plant for concrete pavements is now commending itself on many projects. In most cases the ready-mixed concrete is hauled to the construction by means of trucks. The only detail in this method which can be considered questionable at this time, is the transferring of the concrete from the trucks. It is possible in many cases that there is a segregation of aggregates and, no doubt, this detail must be overcome, but this method of construction is bound to gain in popularity from year to year.

In a few instances engineers are calling for a piece of bituminous surface road to be constructed of 1-2-4 concrete and requiring that the concrete base be properly cured, as called for in concrete surface, for a period of at least two weeks.

Burlap Covering of Green Concrete Pavements

For a long time the curing of concrete pavements has been neglected, and it is only recently that this detail of construction has been given the proper attention. One of the most important developments which has been brought about recently is the use of the burlap covering in the early curing of concrete surface. The finished pavement is covered with strips of burlap, approximately 4 ft. in width, and extending the entire width of the pavement. This burlap is kept wet and then placed on the finished concrete surface from about 10 to 20 ft. back of the finishing operation. The slight marking of the surface from the burlap is negligible. The burlap should never be allowed to dry out and thus the concrete does not lack the necessary water for hydrating in the early periods, a condition which has often existed in the other methods of curing concrete roads. I consider that this is one of the greatest developments of details, and one which has actually improved the lasting quality of concrete. As soon as the road surface becomes hardened the burlap is rolled up and ready for the next day's work, while the concrete road surface is covered with earth, sprinkled and wet in the usual manner.

Testing Riding Qualities of New Road

Many specifications are now including regulations as to the riding qualities and evenness of the concrete road surface. Ordinarily this cannot be tested until the next day when the concrete has hardened sufficiently to bear one's weight. Recently there has been an appliance invented which consists of an extremely light straight edge, which may be fastened to the end of two handles in order to reach out to the road surface and test the surface before it has become hardened.

Many other experiments have been carried out in the detail of curing concrete pavements, but no definite results have

been obtained. One state has used calcium chloride in solution applied on approximately 1 in. of earth covering. Another method tried has been the covering of the concrete surface with a heavy asphaltic oil. The oil was applied to the road in the proportion of about 6/10 gal. per sq. yd., and in two weeks' curing period the asphalt was peeled off and again used. No definite recommendation is made at the present time in regard to this method.

Oiling Subgrade

Another extraordinary experiment has consisted of the oiling of the subgrade preparatory to the laying of the concrete pavement, the object being to prevent mud during the light showers. It has been found that when the light truck is used this oiling proves to be a considerable advantage, and, no doubt the oil offers some assistance to the stabilization of the subgrade.

Steel Bar Reinforcement

While for a long time it has been customary to use wire fabric in the reinforcement of concrete highways, steel bars are occasionally used, and while there has been no development in regard to the use of this fabric reinforcement, there is, however, a change in the method of using steel bars. The new development consists of making these bars into a mat, consisting approximately of 10 to 14 bars transversely, and about 5 bars longitudinally. The mat is then wired together and handled as sheet reinforcement.

The use of dowels at the transverse construction joint can hardly be considered as new, as this method has been carried on for several years, and found to be very satisfactory in overcoming the tendency of one slab to rise above the other.

Using Fibre Conduits Across Roads

Another method in construction detail is the installation of fibre conduits placed transversely across the road at various intervals, especially through small towns and villages. It is the function of these conduits to provide a means for gas, water and electric wiring to cross the road without making it necessary to break up the pavement.

Bituminous and Brick Developments

In the construction of sheet asphalt surfaces there is a tendency to be more liberal in the grading of sand aggregates, and the use of a lower penetration asphalt. There is also an inclination to use a 3-wheel roller in compacting the sheet asphalt surface. While this is not absolutely new, its use has never been universal.

Another new development is in the combining of a binder course and sheet asphalt surface in the one course, which virtually consists of a stone-filled sheet asphalt; the stone composing from 25 to 60 per cent of the entire surface. When this surface is used no binder course is laid, and the surface is compacted as an ordinary asphaltic concrete.

Recent developments in brick pavements have shown that the vertical fibre brick laid on a concrete base and sand cushion, grouted with a bituminous material is capable of withstanding the ravages of traffic.

"Progressive Type" of Road in North Carolina

The findings of the Subgrade Committee, of which Senator du Pont is Chairman, have shown that the traffic-bearing properties of the pavement depend greatly upon the stability of the subgrades, and that the subgrade can be greatly stabilized by being mixed or covered with a non-capillary material, such as sand, gravel or top soil. This has lead to the development of what, in North Carolina, has been termed the "Progressive Type" road, which consists, first, of the grading of the road and the building of drainage structures, and then surfacing with a non-capillary material, such as gravel, sand clay or top soil, which, in truth, is nothing more than the construction of a subgrade highway for a future constructed hard surface pavement. This can be maintained as a subgrade highway for medium traffic at a reasonable cost, and, when occasion demands, it can serve as a high bearing value subgrade for any type of surface desired. This method of construction means that all previous steps in the construction have been preserved and that the completion of a hard surface road is merely an addition; there being no economic loss whatever, due to the fact that the previous work is incorporated into the completed hard surface road.

I would not consider this paper complete without describing one of the new methods we are trying, and which promises to be very satisfactory in the treatment of constructed subgrade highways, now being utilized as roads, and in the treatment of top soil or sand clay roads.

Many states are situated similarly to North Carolina to the extent of having a large mileage of sand clay top soil, or gravel surfaces.

There has been much experimenting in the attempt to secure a bituminous material which would satisfactorily preserve this type of road surface. It was generally found that any bituminous material sufficiently light to penetrate this surface would have practically no binding qualities, and that any bituminous material sufficiently heavy to have binding qualities would form a mat on the top of the road surface, and soon peel off, due to the dusting of the road surface directly underneath the bituminous covering. The weak point in this treatment was not in the bituminous blanket, but in the contact of the bituminous blanket with the road surface.

North Carolina is attempting to develop a method which will correct this weakness, and provide a contact between the bituminous covering and the road surface. The method consists of softening the road surface by means of sprinkling and then rolling into this surface broken stone or gravel of approximately 1½ ins. in size. After this has become thoroughly imbedded in the top soil or sand clay it is allowed to dry out, and subjected to traffic for a short period, after which it is swept clean by brooming. The road surface now consists of a single layer of crushed stone imbedded in the strong and rigid sand clay or top soil surface, and forms a satisfactory bond of contact for the bituminous material. Thus a sufficiently heavy material to have binding qualities can be applied to this sand clay road, and the layer of broken stone will prevent the dusting up of the road surface directly underneath the bituminous mat. By waterproofing the top soil or sand clay in this manner, a strong pavement is preserved and after the first application of the bituminous material a mat can be built by using various types of pavement. While this method has not been in practice long enough to prove its complete success, the developments show that for a slight expenditure a sand clay or top soil road can be materially improved.

Although road surfaces seem to have already resolved themselves into certain types, unless new materials are found or new treatments of the present materials discovered, the general types of pavements will probably not change to any great extent; nevertheless the constant discovery of weakness and economic extravagances makes it absolutely necessary for highway engineers continually to keep well posted in the new developments in details followed in the construction of modern type pavements.

The foregoing paper was presented before the recent annual convention of the American Association of State Highway Officials.

SUCCESSFUL COMMUNITY HEATING AT ARCADE, NEW YORK, WITH EXHAUST STEAM FROM LIGHTING PLANT

Municipalities or communities having electric light or other plants in which steam is used as power would profit by studying the experience of Arcade, a village of 1,300 in Wyoming county, New York. Arcade has made a success of municipal ownership and operation of two public utilities. While the plants are not large as municipal enterprises go, their growth and development show in a striking way what can be done along this line by a community, large or small, proceeding carefully and acting upon sound business principles.

Exhaust Steam Utilized

The utilities are lighting and heating. Lighting is placed first because in this instance it was an electric lighting plant that was first put into operation, a heating plant being added to utilize the steam back of the lighting plant after it has performed its initial function of generating electric current. For many years this steam was waste, puffing into white clouds of vapor through the roof—a familiar sight in many like plants.

The utilization of this waste, placing the nose of the exhaust pipe underground and distributing the steam to serve virtually every business place in the village, is the achievement that reflects greatest credit upon the village boards and the administration of the electric light system, now the combined light and heat plant of Arcade.

Advantages of Combined Lighting and Heating Plants

The dual plant not only conserves several hundred tons of coal during every winter month, but also accomplishes these important things:

Reduces the fire hazard in individual

buildings and thus lowers the insurance rate.

Does away with the dust and dirt incident to the operation of basement heating plants in stores and office buildings.

Relieves the community of anxiety over a shortage of coal for domestic consumption.

Furnishes steam heat to customers at a cost about equal to what they formerly paid for fuel, not counting the labor involved in individual heating appliances.

Finally, and this is more important to the engineering than to the lay mind, the condensation is brought back from the street mains to the electric plant through a return pipe, furnishing distilled water for the boilers to the extent of 75 per cent. of the total amount of water used.

The Lighting Plant

The electric light plant was built about thirteen years ago. Like many other enterprises of the sort, it took a good many years to put it on a paying basis, giving the consumers ample current at a rate equal to or lower than it would be furnished by a corporation seeking to pay dividends to stockholders. But it was accomplished. Five years ago it reached the self-sustaining stage. It now furnishes current for lighting the villages of Yorkshire, Sandusky and Delevan, all within a radius of five miles of Arcade. Arcade meters and collects in Yorkshire and Sandusky and sells a block of current to the village of Delevan.

One of the difficult problems facing the electric light administration was to get an evenly balanced load over the 24 hours. The first users, of course, brought the peak of the load from early evening until midnight. A knitting mill was induced to install electrical equipment and become a customer of the city and a vigorous campaign of education in the use of things electrical resulted in the installation of a considerable number of electric ranges, irons and other domestic equipment. The result was a fair distribution of load throughout the day and night.

Utilization of Waste Heat Proposed

About this time the question of utilizing the steam exhaust at the electric light plant was revived after lying dormant for several years. L. A. Mason, then in charge of the electric light plant, wanted a survey made. He asked the then village board for an appropriation to pay an engineer to make one. The board was conservative. It was willing to consider a proposal to use the steam for heating the school building, located across the street from the lighting plant, but refused to vote for a survey having in view a general village heating system. That laid the proposition on the table for another year.

As the electric light plant grew and took on new customers at home and in the adjacent villages, it became necessary to install a duplicate boiler system to provide against emergencies. A view of the power plant in shown in Fig. 1. When the plant enlargement proposal was taken up by the village board the heating plant idea was again injected by its supporters, but another deadlock seemed likely to develop. A representative of a steamfitters, supply house who happened to be on the ground in connection with the alterations at the electric light station heard of the situation and volunteered to have one of the firm's engineers make a survey without cost to the community.

FIG. 1—ELECTRIC LIGHTING POWER PLANT AT ARCADE, N. Y., DIRECTLY ACROSS STREET FROM SCHOOL BUILDINGS AND BLOCK FIRST HEATED BY EXHAUST STEAM FROM THIS 475 B. H. P. PLANT.

His offer was accepted and after the survey was made, a meeting of the business men of the village was called to talk things over. The upshot of it all was that the proposal went to the taxpayers and the board was authorized to issue bonds to the extent of $12,000 for the installation of steam mains on the north side of the main business thoroughfare, which is nearest to the electric light station, see Fig. 2.

Contract Awarded for Heating Mains

The contract for the installation of the steam distributing plant was awarded and work was begun in October, 1920. Weather conditions were not conducive to rapid progress and it was not until January, 1921, that steam radiators began to take the place of stoves, furnaces and individual steam-heating plants in the business blocks on the north side. The first consumers were highly pleased with the service and it was not long before business places on the south side of the street began to ask for an extension of the main.

Influence on School Affairs

The village had voted to spend $100,000 for a new school building, but construction was delayed because of the high bids submitted. The old school, see Fig. 3, a three-story frame structure, had no less than six fires in the basement under various systems of heating, direct, hot air and hot water. They were expensive, inefficient and because of the fire risk, use of the third floor was forbidden by the fire underwriters, compelling the board of education to spend over nine hundred dollars a year for quarters outside the school building.

FIG. 3—FRAME SCHOOL BUILDING TO WHICH STEAM MAINS WERE LAID, TAKING PLACE OF HOT AIR FURNACES.

The Third Floor of this Building is now Available and Used for School Purposes, with Permission of State Inspectors, Due to Introduction of Steam Heating and Removal of Hot Air Furnaces.

Architects for the new building were consulted to find out what sort of Indirect Heating coils were to be used in the proposed new schoolhouse and to learn whether it would be possible to install them in the old building and remove and use them in the new schoolhouse when the time came to build.

FIG. 2—NORTH SIDE OF MAIN STREET, ARCADE, N. Y. ALL BUILDINGS SERVED WITH STEAM FROM CENTRAL PLANT. FIRE HAZARD REMOVED IN THIS ROW OF BUILDINGS.

FIG. 4—MASONIC LODGE BUILDING, THE FIRST CONNECTION MADE IN THE SECOND INSTALLATION OF UNDERGROUND STEAM MAINS AT ARCADE, N. Y.

It was found that such a plan was feasible. So the proposal to take care of the south side of Main street, see Fig. 4, was coupled up with the schoolhouse heating plans and the tapayers voted to authorize another bond issue of $12,000 to cover the expense. This year the extension of a main to the south side was completed and another main was carried across the street to the old schoolhouse in which the new heating system will be ready before snow flies. The Hot Air Furnace equipment removed from the school buildings included built-in-boxes with wooden frames for the reception of the pipes. These box frames were found to be very dry, and in some cases charred, so that a fire threatening life and property loss was easily possible.

Last winter partly because of the mild weather only about one-third of the exhaust steam was used. This winter with 24 taps for buildings of all sizes and the schoolhouse, there still will be more than enough from the engine exhaust to furnish first class service.

Heat Available if Lighting Plant is Temporarily Shut Down

Provision has been made to continue the steam heating part of the plant in the event of an accident or any contingency involving a temporary shutdown of the electric light station. A direct feed pipe connects the boilers with the mains through which live steam can be sent when the supply from the exhaust is cut off or runs too low. This direct steam service also will supplement the exhaust flow during extremely cold weather. The

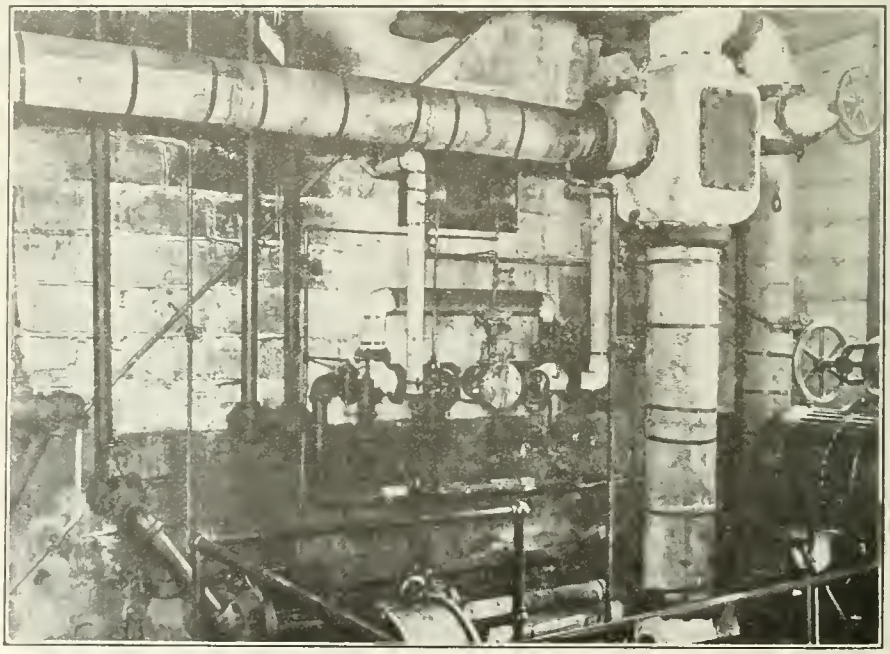


FIG. 5—PIPING REQUIREMENTS IN BOILER PLANT, WITH REGULATING VALVES CONTROLLING HEATING SUPPLY AT ARCADE, N. Y. ALL CONTROL IS AUTOMATIC.

piping requirements which permit of the automatic supply of exhaust or live steam, as may be required, require no extra room, see Fig. 5. Should emergency arise, all steam valves are immediately available to the engineer, being within a few feet of the engine valve.

Financial Aspects

The $24,000 bonds which cover the entire cost of the steam distributing part of the plant carry an interest charge of $1,440 a year. The revenue from the present number of steam service customers is sufficient to pay the interest and retire the bonds at the rate of $2,000 a year. In a few years, therefore, the plant will have paid for itself and become a revenue producer for the municipality, at the same time giving an eminently satisfactory heating service to the entire business part of the village at a cost below what individuals and firms had been paying for fuel. And the school building will be comfortably heated, the fire risk immeasurably reduced and the three floors open for use. This third floor of the frame school building having been idle for a number of years, due to the order of the fire commissioner of the state, it is noteworthy that the cost to the school commissioners for rented premises has, by this introduction of central heating, been entirely eliminated.

Another important result will be the great reduction of fire risk in the business section.

Converting an Objector

Of course the opposition did not die in a day in Arcade. Only recently a well-to-do citizen who did not keep in close touch with municipal affairs blustered into the office, thumped his fist on the desk and declared he was going to call a halt to what he called "reckless expenditure of the village's money on experiments."

"I am asked to pay for something for the benefit and convenience of others," he said.

An executive invited him into the office, had the books brought in and gave him figures to prove that the dual plant had become a tax-producer and not a tax-eater.

"This plant has not called for the investment of one dollar of the taxpayers' money," the executive explained to him. "It is paying as it goes and produces sufficient revenue to retire the bonds the proceeds of which were used for the improvement. All that you have actually done is to loan your credit to float the bond issue."

Mr. Taxpayer went away satisfied and a little prouder of his home town.

Ultimately Arcade's steam plant, using what for years had been a waste product, will produce a revenue of between $5,000 and $5,700 a year for the village treasury, it is estimated, and there will be no long term bonds for future generations to pay.

Patrons Are Well Satisfied

Are Arcade customers of the steam plant satisfied with the results of their venture, both as users and taxpayers? Here is what some of them say about it:

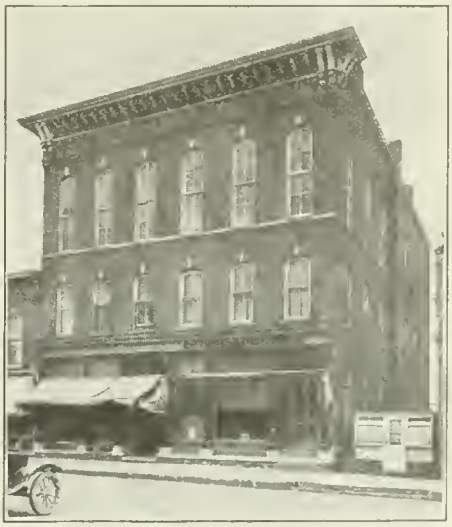


FIG. 6—CITIZENS BANK, ARCADE, N. Y., FIRST BUILDING SERVED WITH STEAM FROM MUNICIPAL PLANT ON NORTH SIDE OF MAIN STREET.

J. H. Smith, cashier, Citizens Bank of Arcade: "Last year we had our banking building, see Fig. 6, connected up with the Exhaust Steam System from the Village Electric Light Plant.

"While we were very sure this system would be a success, we are more than pleased with the system and the way it works. Many said it would never work, but it does and works perfectly and we figure that it saves us money besides doing away with all trouble and dirt from a furnace, and at the same time it is a good money maker for the Village of Arcade.

"Our building (Keystone Block) is 45 x 80 and three stories high above the ground and this is now well heated in all parts of the building.

"The work in putting in this system has been perfect and the contractor seemed to know just how to install the

system and have it right and perfect when completed."

Cottrill & Cottrill, pharmacists: "We have used the municipal heat since last January and are very much pleased with it. It has been perfectly satisfactory in every respect and everyone who has used it cannot speak too highly of it. It is absolutely clean, dustless, fireproof and takes practically no attention. The water heaters used in connection with it are also a great advantage."

B. R. Taber, H. M. Taber & Son, general hardware store: "We were one of the first to have the steam heat installed in our store, and the two upper flats over our store by the Village of Arcade. We used this heat during the winter of 1920 and found to our delight that we had the best heating system anyone could wish for. Without doubht this system will prove profitable to the taxpayers of the village, as this heat is furnished by exhaust steam from the Electric Light Plant. This steam had been a total loss before this heating system was installed. The company who installed this system furnished men who seemed to be experts in their work. The installation was done in a very neat and satisfactory manner."

Frank F. Hammond, Amusu Theater: "I have been a user of the village steam heat for about nine months, to my entire satisfaction. To my mind Arcade is to be congratulated for having established this municipal plant, both from an economic standpoint and for the saving of worry, labor and dirt to the users thereof."

O. T. Wilson, The Wilson Land and Grain Company: "Nearly one year ago, we connected up our heating system in two buildings with the central heating system, one of which buildings is an exclusive office building occupied in part by the postoffice of this village. This building had formerly been heated with a steam system. We connected the same without change in any respect of our previous installation.

"Another block was occupied on the ground floor as stores and the second floor was occupied as four separate flats, which block was formerly heated by a vapor system and was connected with the central heating system without change of installation.

"We also connected up and use steam from the central heating system for the purpose of heating water used for domestic purposes in both of the blocks.

"We are glad to state that now after nearly one year of continual use we are exceedingly well pleased with the plan of heating and the steadiness of the heat gives much greater satisfaction to our tenants than our former method.

"We have had absolutely no complaint from tenants relative to the heat of the water for domestic use.

"In conclusion will say that we have only words of commendation in expression of our feelings upon this subject."

The members of the present village board of Arcade are D. C. Bentley, assistant cashier, Citizens Bank of Arcade; L. S. Bentley, attorney, and Charles E. Buchman. L. S. Bentley is village president. L. A. Mason is clerk of the board.

USING THE STANDARDIZED PAVING BRICK

By W. W. Horner, Chief Engineer Sewers and Paving, City Hall, St. Louis, Mo.

We who have been particularly proud of the growing importance of the industrial engineer have watched with much interest the work of Mr. Hoover's committee, of the American Engineering Council, on the elimination of waste in Industry. Some of us have been amused at the information contained in the committee's voluminous report, but have hesitated in anticipating any material accomplishments through these findings. Therefore, to municipal engineers at least, the results of the recent conference, called by the Department of Commerce to consider the possibility of elimination of waste in the paving brick industry through standardization of the product, are most gratifying. At this conference 14 engineering and technical societies met with representatives of the government departments, and of the paving brick industry, and discussed the elimination of excess sizes and varieties of brick.

In his opening address Mr. Hoover stated: "Obviously the consumer is the engineer as he makes the specifications and directs the purchase. The manufacturers are helpless to come to any conclusion of this kind unless they can have the co-operation of the engineers who make the specifications and finally pass upon these matters. * * * This is the first time that we have attempted to bring the groups together, first, the manufacturer, then those who dominate his consumption. So that I am in hope that we can get results." The results obtained were extremely interesting and worthy of detailed study and analysis.

The Standard Varieties

They were aimed at the elimination of waste in this particular industry; that is, in the manufacture of paving brick. In this direction there is no doubt that the accomplishments are of signal value. Briefly, the number of varieties was reduced from 66 to 11, all of which can be made from three sizes of clay column. There remain as accepted standards three depths of brick, that is, 3-in., 3½-in. and 4-in., and two widths, 4-in. and 3½-in. More specifically, we are to have 3-in. brick in 4-in. width in both plain wire cut and with the moulded lug. Also the side wire cut lug brick in a 3½-in. width. The same three styles are provided in the 3½-in. depth, and there is included in addition the repressed brick in the 3½x3½ dimensions. All 4-in. brick are 3½ ins. in width, and include the repressed type, and the side wire cut lug type in both the ordinary paving brick, and in the hillside brick. Also the 3-in. lugless brick may be laid on edge, making a 4-in. depth of brick with a 3-in. width plain side wire cut.

Laying of 3-in. brick flat instead of on edge may require a less number of brick per square yard, but as the prices of brick are governed by the weight it is not a question of the number of brick; furthermore, a small lug on the brick to provide spacing naturally reduces the weight as compared to the weight of a square yard of the lugless type.

With this great achievement secured in the factory end of the paving brick industry, it is interesting from the engineering viewpoint to analyze the use of these brick, that is, to determine their treatment to the best advantage by the other great industry involved, the one which provides brick *pavements* for our streets and roads. In this industry there might occur not only the waste of poor organization methods, but a possibly much greater waste in poor design and construction.

The Depth of Brick

Considering first the depth of brick, the writer feels that the 4-in. depth provides all that is needed for the heaviest traffic, and that the 3½-in. brick may be used to good advantage, that in its use the cost of transportation enters materially into the cost of the finished pavement. The 3-in. brick cannot be so easily disposed of. While it may give satisfactory service for some time under moderate traffic the writer feels that it has inherent defects which should be seriously considered by the engineer in designing the pavement. The first of these lies in its large surface area as compared with its depth. (With any type of pavement the bond of the surface must be more insesure with the 3-in. than with the other varieties.) With a 4x8½-in. surface it is absolutely necessary to secure a perfect bedding with the brick, in order that it may not be broken under wheel impact. The mere bedding of the brick under the weight of 5-ton roller will be sufficient to break many of the units before the pavement is completed. The writer has had experiences of this character where 3-in. brick were used on a cushion of screenings or of sand and cement in the sand-monolithic type of pavement, the breakage being so great as to make the actual construction costly.

On account of the thinness of the brick wearing surface the effect of temperature stresses in the cement grouted pavements is extremely destructive, and it would seem highly advisable to consider the 3-in. brick only with bituminous fillers, if at all. The writer wishes to question at this point whether the life of the 3-in. pavements which we are now laying will be sufficient to justify the small saving in first cost involved in the use of this depth of brick. This question may be given emphasis in view of the results of the recent impact tests of the Bureau of Public Roads on pavement slabs.

The Style of Brick to be Used

The next question confronting the engineer is the selection of the style of brick, which are only valuable for a spebrick, which areo nly valuable for a special purpose, he has the choice for his 4-in. surface between the old style repressed brick, with or without lugs, and the side wire cut lug brick.

In making a decision on this point the conclusions of Messrs. Goldbeck and Jackson, of the United States Bureau of Public Roads, as published in "Public Roads" of February, 1919, are of particular interest. "Paving brick with well-formed contact lugs are to be preferred to brick without lugs. ' Paving brick with square edges are to be preferred to brick with round edges." The City of St. Louis, in investigating the condition of its brick streets in 1914, all of which had been repressed lug brick with cement grout filler, came to the conclusion that among the outstanding defects in these older pavements was the failure of the

grout to adhere to the round edges of the repressed brick, and the spalling off of surface laminations under temperature stresses, and under the wear of steel tire traffic. As a result of this investigation, and in the desire to secure a more satisfactory space for grouting, the repressed brick were eliminated from the St. Louis specifications, and side wire cut lug brick have been used exclusively since that date. This decision seems to be well justified by the report of the accelerated wear tests of the Bureau of Public Roads recently published, in which it was noted that: "The tests would indicate that in resistance to wear the wire cut lug brick ranks above the repressed." And again: "Also the fillers, both asphalt and cement grout, offer considerably more protection and support to the edges of wire cut lug than to those of the repressed brick." That the conclusions here drawn are receiving general acceptance is evident by the decreased production of repressed lug brick, which has fallen from 323,000,000 in 1914 to about 73,000,000 in 1920, as compared to the total production of the two years of 451,000,000 in 1914 and 301,000,000 in 1920.

In the 3½-in. depth the same considerations are involved as between the repressed and the side wire cut lug brick. In this depth, however, the engineer will still have the choice of a 3½-in. vertical fibre lug brick, and of a 3½-in. plain wire cut brick without lugs. The vertical fibre lug brick will possess many of the advantages of the side wire cut lug brick. Its principal disadvantages in comparison are the large uniform lugs which cut the filler space up into small chambers more difficult to fill and to waterproof the foundation, and in the smooth sides which cannot be quite so satisfactory in regard to the adherence of the filler as is the rough side offered by the wire cut lug.

The plain wire cut lugless brick has been the subject of much controversy in recent years. This brick was originally brought out by the Paving Brick Manufacturers' Association in 1919, in what was apparently an attempt at standardization. While thoroughly in accord with the necessity for standardizing on a few types, engineers generally have been unable to approve the choice of this type as a standard. The writer expressed his opinion of this matter in that year, and desires to repeat with emphasis the statement then made. "The lugless brick means a brick with very small and inadequate spaces for joint filling. All our experience has indicated that one of the greatest defects in brick paving has been incomplete joint filling. That this experience is quite general has been indicated by the increasing use of lugs and the employment of other methods for providing a wide, free space for filled penetration." Mr. R. Keith Compton, Chairman of the Baltimore Paving Commission, states that "Lugs are absolutely necessary for the proper flow, no matter what filler is used."

After a thorough investigation the brick committee of the American Society for Municipal Improvements, at the meeting of the Society in Baltimore in October, 1921, recommended a revised specification which provides for regular repressed brick with lugs, for wire cut brick with wire cut lugs, and plain wire cut brick with lugs for cement grout and bituminous filler, but eliminating entirely the type which some manufacturers have been urging as a standard. If Mr. Hoover is correct, that the consumer is the engineer, this decision by the most important committee of engineers having any connection with this matter should be final.

All the consideration applying to the 3½-in. brick apply with equal or greater value to the 3-in. brick, with the possible exception that the 3-in. side wire cut lug brick, being only 3½ ins. in width, presents a more normal relation of surface area to depth than does the 4-in. width. The writer has already expressed his doubt of the ultimate value of the 3-in. brick for paving purposes and would only suggest further that, where used at all, all details of construction should be as nearly ideal as possible, including a proper provision for joint spaces to secure a satisfactory penetration of the filler.

The Bedding Course

Aside from the character of the brick used, a satisfactory brick pavement surface involves also the proper design of the bedding course and filler. For the bedding course three materials are in common use. First, the sand cushion, which was at one time universal, but which has been discarded in a great number of instances. Second, the sand-cement mixture providing the semi-monolithic type of pavement, and, finally, the so-called monolithic type involving the laying of the brick on the wet concrete.

While good pavements have been secured with a sand cushion in some localities, sand in many places has been found unsatisfactory. The sand cushion should never be used except where a satisfactory grade of sand is available, and should certainly not be used with a cement grout filler. On the other extreme, the so-called monolithic type has rarely been found to live up to its name, as temperature stresses in the pavement are inclined to create a movement of the wearing surface, which ultimately breaks the bond. It is to be highly recommended, however, where construction conditions permit of its use economically, for the reason that it is sure to permit of a true bedding of the brick. The sand and cement mixture has been found quite satisfactory. It permits the facility of construction which a sand cushion does not, and with it a smoother surface can be secured than is usually possible with a monolithic type. While it requires careful watching to see that the cushion is not broken while the cement is taking the initial set, it is otherwise simple to handle, and the ultimate strength of the cushion is at times surprisingly high. Of the three types the writer considers it the most valuable in brick paving, regardless of the kind of filler used.

The Choice of Filler

At this time opinion seems to be about equally divided in the choice of filler as between cement grout, bituminous, or bituminous mastic. Where the brick is laid on a strong concrete foundation supported by a well-drained soil, the writer invariably prefers the cement grout as giving to the wearing surface a slab strength over small areas which is of value. If on flexible foundations or on clay soil subject to frost and heaving, a bituminous type of filler is probably a safer choice. When properly handled it is somewhat easier to secure good penetration with a bituminous filler than with cement grout. It has been argued that this ease of penetration with bituminous fillers justifies the omission of lugs, but an examination of recent pavements around the country, and reports from engineers in the technical press, do not bear out this contention. There is apparently a great deal of so-called vertical fiber pavements laid without lugs, in which the filler fails to penetrate materially, and is squeegeed over the surface in the form of an asphaltic or mastic mat. The defect is not apparent in the new pavement, but in the course of a short time, depending on the amount of traffic, this mat breaks up or wears off, and the brick have been found to be loose and the joints largely empty.

The filler in a brick pavement has three functions to perform. First, to hold the brick units solidly in position in order to create and maintain a smooth, continuous pavement layer. Second, to waterproof the pavement and prevent the entrance of moisture into the cushion with consequent disintegration and heaving; and, finally, to protect the edges of the brick from breaking down under traffic. It is evident that properly to carry out these functions the filling of the joints must be complete, and that the bridging of the joints and the creation of the mat of wasted materials which is seen in so many vertical fiber pavements is not good engineering practice.

The writer believes that the lugs heretofore used on both wire cut and repressed brick are somewhat larger than necessary for this purpose, and that in the case of the bituminous filler a ⅛-in. lug will be satisfactory.

In view of the possibilities outlined above it seems advisable to raise the question whether efforts to reduce the cost of the pavement in some cases are not carrying us into a design that is economically unsound and whether the ultimate waste in pavement failures on this account may not be far greater than the waste we have been attempting to eliminate in the standardization of brick. The writer believes that the consumer, in this case the engineering profession, should seriously consider whether conservative specifications such as those of the American Society for Municipal Improvements should not be more strictly adhered to even where the cost involved would be somewhat greater than the first cost of certain of our pavements. If these specifications were adopted quite generally by the profession there would not only be eliminated this possibility of waste, but there would be further elimination in the styles of brick in that the plain wire cut lugless brick in both 3 and 3½-in. depths could be dropped, and that possibly it might ultimately be wise to drop also the other styles of 3-in. brick.

The foregoing paper by Mr. Horner was presented at the recent annual meeting of the American Road Builders' Association.

OVERCOMING CRACKING AND EXPANSION JOINT TROUBLES IN LUCAS COUNTY, OHIO, CONCRETE ROADS

Lucas, County, Ohio, of which Toledo is the county seat, for the past six years has had a concrete road program, initiated primarily by the County Engineer and carried on by public sentiment. The only objection to this type of pavement was the development of cracks which continued to increase in numbers and size as the pavement grew older. How this difficulty was handled by the engineers is described by Mr. E. D. Keil, of the County Engineering Staff, as follows:

To minimize the development of cracks and to keep them from opening, Truscon wire mesh weighing 40 lbs. per 100 sq. ft. was placed 2 ins. below the slab surface. This mesh is manufactured, shipped and placed in flat sheets 6 ft. wide and cut to the desired length, thus eliminating straightening and cutting in the field.

The effect of this steel mesh in the slab is obvious. Cracks were reduced to the minimum; the saving in maintenance alone offsets the cost of installation, which is negligible.

The preservation of the integrity of the pavement by minimizing the number and size of the cracks met with universal approval.

Much trouble had been experienced in getting a smooth finish at the joints as precast or mastic joint was used. Hand finishing was resorted to when the mechanical finishing machines reached the joint.

To overcome this difficulty Truscon dowel contraction joints made of 16-gauge steel were substituted for the mastic joint three years ago. The results were so favorable, the installation so simple and inexpensive that its use is now specified on all Lucas County concrete highways.

The contraction joint extends from the sub-grade through the slab to within 1 in. of the surface. It forms a plane of weakness across the slab so when the concrete contracts, the crack which is bound to develop is straight across the pavement directly above the steel plate, eliminating the unsightly and expensive-to-maintain cracks that formerly ran at random over the pavement following the weakest plane.

The joints are cut to the width of the pavement and to the crown of the metal. The 2-in. dowel in the plate increases its rigidity, making it easy to handle and forms a mechanical lock of the slabs which prevents one slab creeping up on the adjoining slab, thereby eliminating intensified impact pressure always produced by traffic going over an uneven surface, which is so common where other joints are installed.

CONTRACTION JOINT INSTALLATION, DOUGLAS ROAD, LUCAS COUNTY, OHIO.

Concrete placed during the construction season is usually at its maximum expansion at the time it is being placed. Any additional expansion in the dowel jointed pavement after it is laid is deevloped transversely and is effected without fracture, due to the elasticity of the reinforced

Spreading the Gospel of Mudless, Dustless, All-year Roads—

WHEREVER you have seen one of these trucks at work you may be sure that GOOD ROADS have come to that community. For the Tarvia Truck Sprayer is the herald of smooth, dustless, mudless "all-year" roads that are less expensive to build and maintain than any other type of modern highway.

How about the roads in *your* community?

If you have *any* road problems—either construction, maintenance or repairs—put them up *today* to the engineers of our Special Service Department. Their advice, based on wide experience with every type of highway construction, is free for the asking—and it involves no obligation whatever on your part. Please address your letter to our nearest branch.

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concrete. However, the principal tendency is toward contraction, and this is properly cared for along the length of the pavement by contraction joints and across the width of the pavement by the reinforcing steel.

Joints are specified every 50 ft. on pavements 16 to 20 ft. in width and are placed at right angles to the center line of the pavement.

The Lucas County road work was designed and constructed under the supervision of Cecil L. Rood, County Engineer, Toledo, Ohio. Steel contraction joints and reinforcing steel were furnished by the Truscon Steel Co., Youngstown, O. In the carrying out of the road program in Lucas County, as outlined above, there were many awards to contractors known throughout the Middle West. Among them were Warner & McKechnie, Peters Bros., Johnson, Van Wagner & Johnson, Herman Lindsay and Peter Waters.

LAYING SHEET ASPHALT OVER RUTTED ASPHALT BLOCK PAVEMENT AT BRIDGETON, N. J.

By H. T. Macfarland, of Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa.

Utilizing as a sub-base 20-year-old asphalt blocks which had been disrupted by heavy motor traffic and many street openings, Bridgeton, N. J., recently laid modern sheet asphalt pavements on a number of main business thoroughfares in an unusually economical schedule.

By resurfacing the old natural asphalt block wearing surfaces, instead of tearing them up and laying new cement concrete foundations, it is estimated that a saving of approximately $65,000 to the taxpayers was effected.

The success of the resurfacing operations conducted during 1921 has been so pronounced that the general scheme for improvements probably will be followed through 1922.

An investigation of highway conditions in Bridgeton was started in February, 1921, when Remington & Vosbury, of Camden, N. J., were engaged as consulting engineers to study the situation and outline a paving program for 1921 and 1922.

The investigation covered a number of streets in the central district, which had been paved about 20 years ago with bituminous blocks on a gravel base. These blocks had given splendid service for a number of years. In recent years, however, the burden of heavy motor trucks and failure to fill trenches and openings for the installation of water mains, sewers and other underground structures, had resulted in badly rutted and broken pavements.

The bituminous blocks, of natural asphalt, were tested and a large percentage were found to be full of life and in an excellent state of preservation.

A careful study and tests of sub-soil conditions then were made, and as a result of the analysis the engineers decided to salvage the blocks to use as a sub-base for wearing surfaces of 2-in. Bermudez Sheet Asphalt wearing surfaces.

Along curb lines and trolley tracks, in many instances, it was necessary to take up the bituminous blocks, regrade the subsoil and restore the blocks on a lower plane to make room for the 2-in. wearing surface.

After the blocks had been placed on the proper grade, the surface was carefully swept and then painted with emulsified asphalt, applied at the rate of 1/5 gal. to the square yard. This paint coat also was applied to the face of the curb, and to the edge of the stringer brick along the trolley track, where the sheet asphalt was to join.

All depressions were filled in with binder, to bring them up to the proper grade. Then the binder course was laid and the sheet asphalt wearing surface put down.

Bermudez Lake Asphalt was used with a carefully selected and proportioned grading of sand and limestone dust.

The sheet asphalt surface was laid at a cost of $1.86 per sq. yd. The binder was furnished in place by the ton, a unit price being established per ton for trap rock and a unit price per gallon for the native lake asphalt. There were 25,670 sq. yds. of sheet asphalt surface laid in Bridgeton.

The work was performed under the supervision of the engineers, and the Highway Committee of City Council, William B. Holmes, Chairman, and William T. Lanning. A. H. Lupton was the Commissioner of Streets. The contractors were the E. Riley Mixner Co., of Goshen, N. J.

The entire resurfacing operation in Bridgeton was completed in 46 working days. Upon its completion, Council unanimously approved the work, and it is expected the program for 1922 will be followed without digression.

WATER WORKS SECTION

UNDERGROUND VS. SURFACE WATER SUPPLIES WITH SPECIAL REFERENCE TO WAUSEON, OHIO

By W. J. Sherman, Consulting Engineer, 618 The Nasby, Toledo, Ohio.

American water works construction received its first great impetus with the discovery that water works bonds were a good investment.

Forty years ago the advertising pages of the magazines carried many invitations to the investing public to purchase securities of this class. Bond houses specializing in water works bonds, were to be found in all the Eastern cities. New England seemed to be the most fertile field for their sale, with Boston as head quarters for their promoters.

The writer recalls one alluring advertisement calling attention to the safety and security of this class of investment and the good return to the investor. The fact was emphasized that there had never been a default in the payment of principal or interest with investments of this character.

The rapidly developing Middle West afforded a splendid field for promotion activities and many syndicates were formed for operations there.

Early Conditions in the Water Works Field

Water works franchises were sought and easily obtained in hundreds of the smaller cities or towns of this region, municipally owned plants having already been built in most of the larger cities. Franchises were limited by law usually to 25 or 30 years. The interests of neither the investor nor the public were properly safeguarded, due largely to both the inexperience of promoters and the representatives of the public. The fruitful sources of future troubles were in many instances overlooked. A 25-year franchise seemed to provide for a long time in the future. The fact that bonds would mature and that franchises must be renewed or other provision for safeguarding the bondholders and the water consumers was often disregarded. Sinking funds for retirement of bonds were seldom provided for. Provision for a bountiful supply of pure and wholesome water was usually written into the contract, but in many instances was not complied with.

The demands upon the new plant, serving a small population were easily met. Small pumping units and small pipe lines were able to satisfy all the early requirements. Working capital to meet plant demands from time to time and new capital to cover plant extensions, additional or better water supply, water filtration and the like were almost invariably unprovided.

The natural result was a growing dissatisfaction on the part of the public with plant ownership and plant operation under private franchises. In recent years franchise renewals have been difficult to obtain and private water works bond issues have been practically unsaleable.

Today municipal ownership of water works is more in favor than ever before, notwithstanding the fact that there is

PUMPING BASIN AND LOW SERVICE STATION, WAUSEON, OHIO, WATER WORKS.

very little real efficiency in public management.

The promoters of the early water works naturally sought a water supply of minimum initial cost for construction profits were more alluring than the successful operation of the plant in the future. The choice lay between lakes, perennial streams, impounding reservoirs and deep or shallow wells.

In a single middle western state possessing all of these sources of water supply, more than 60 per cent of the water works plants depend upon deep or shallow wells, in other words upon a ground water supply.

With the increase in population has come the pollution of the lakes, streams and other surface water supplies and the gradual lowering of ground water level and increased unreliability of underground supplies. The former difficulty has been and is being met by filtration and the latter by the progressive abandonment of underground sources of water supply in favor of surface water.

Experience at Wauseon

It is concerning the experiences of an Ohio town with deep wells as a source of water supply that we are writing in this article.

3,000. Her municipally owned water 3,000. Her municipal owned water works were built nearly 30 years ago. The location chosen was about 2 miles south of the town where the D., T. & I. R. R. crosses a supposedly dependable underground water-bearing gravel deposit. Wells were drilled to a depth of about 220 ft., a neat brick pumping station was constructed, duplicate boilers, pumps and clear wells or pumping basins were provided.

In the early days of the plant the water level in the wells stood near the surface of the ground, but as the years passed, the underground water in this territory in common with practically all the adjacent territory, gradually fell to a lower level, until one day about two years ago, the supply became entirely exhausted, and the town was without water.

This serious condition fortunately developed at a time of the year when most of the surface ditches and small streams were running full. The public fire engine was immediately commandeered and put into commission, feeding the pipe lines of the system through a hydrant, located conveniently near a small ditch, which runs through the outskirts of the town, while preparations for a somewhat more dependable and economic supply were made. A motor-driven pumping unit was located on the banks of the so-called Big Ditch some 3,000 ft. southwest of the old water works station, from which the electric power was obtained.

WASH WATER TANK AND NEW FILTER HOUSE ADJOINING OLD PUMPING STATION, WAUSEON, OHIO, WATER WORKS.

This complete fall-down of the municipal water works was naturally a surprise and distinct shock to most of the people of Wauseon, but within a reasonably short time they authorized a bond issue of

VIEW OF 60,000,000 GAL. RESERVOIR, WAUSEON, OHIO, WATER WORKS.

$170,000 for a new water supply.. This was the maximum amount permissible without exceeding legal limitations and represented additional indebtedness of nearly $60 per capita.

The really difficult problem confronting the engineers for the town was to develop a water supply within the limit of the funds available and satisfactory in all respects, first to the engineers themselves; second, to the Board of Trustees of Public Affairs, which had the water works in charge, and third, and not least, by any means, to the State Department of Health, which possessed the final veto power.

At the outset it was agreed that underground sources would not be considered, after the sorry and expensive experience of the past. There were no lakes or perennial streams within a radius of 8 or 10 miles, and the cost of a supply from such a distance was prohibitive. It seemed therefore, that a local or nearby supply must be developed in some manner.

The main drainage of the town was into a small stream, called Turkey Foot Creek, heading near the north corporation and running southeasterly to the Maumee River. A branch of Turkey Foot from the northeast joined the main stream, two miles east of the Court House. The area drained by this branch was about 7 square miles. There was a fairly good site for an 80,000,000-gal. reservoir just above the junction with a main stream. A half mile away this branch was crossed by three railroads, from one of which—an interurban—electric power could be obtained.

At this fairly inviting location, preliminary plans were developed for reservoir, power-house and filter plant, which were acceptable to all of the parties at interest, excepting the farmers above the reservoir site, who feared their drainage might be interrupted. The opposing influence of the farmer on Board, Council and Merchants of this rural town proved finally to be insurmountable, and this location was therefore abandoned for one near the existing pumping station.

A small stream known locally as the Big Ditch, passed near the old station. The drainage basin above had an area of 4.4 square miles. In certain seasons the channel was entirely dry for months at a time, nevertheless the minimum rainfall as recorded was 21.6 ins. With a run-off assumed at 25 per cent we felt that we had a dependable supply of 5.4 ins. or 414,000,000 gals. per annum. The evaporation and other losses reduced these figures to 378,000,000 gals. This provided fairly well for the present consumption of 110,000,000 gals. per annum, and for the estimated future consumption of double that amount. It was planned to retain the old wells for emergency use when and if needed.

A suitable location in the Valley of the Big Ditch was selected and a 60,000,000-gal. earthen reservoir was constructed, after having detoured the channel of the Big Ditch. At right angles to the new channel a pumping basin 300 ft. in length and 20 ft. across the bottom was excavated just outside the north reservoir embankment. The grade of the bottom of this basin being several feet lower than that of the Big Ditch for obvious reasons.

VIEW OF SIX MOTOR DRIVEN ALLIS-CHALMERS CENTRIFUGAL PUMPS IN LOW SERVICE PUMPING STATION OF WAUSEON, OHIO, WATER WORKS.

The pumping station, a neat brick structure, 16x40 ft., was built at the east end of the basin and in it were installed a battery of 6 motor-driven pumps, four to supply the reservoir and two the new filter plant, 3,000 ft. away.

These 6 pumps in the low service pumping station are all of the motor-driven, centrifugal type and of Allis-Chalmers Manufacturing Co. make. The 4 pumps for reservoir supply are 4, 6, 8 and 10-in. sizes, respectively, and the 2 pumps used for filter house supply are each of 4-in. size.

The reservoir pumps are of different sizes to accommodate the various stages of water in the ditch and pumping basin and have an aggregate capacity of about 7,600,000 gals. per day or sufficient to fill the reservoir in eight days of continuous operation.

The reservoir was actually filled in November of last season without difficulty.

The intake well, gate well and drainage well are substantial circular concrete structures. Water enters the base of the intake well and passes up through 20-in. cast iron pipe, overflowing the top of it in an umbrella-shape stream and falling to the concrete roof of the well, where again it spreads out and falls to the water surface of the reservoir. This arrangement gives fairly good areation to the water supply.

Three 16-in. ports admit water to the gate well at different elevations.

The motor-driven pumps serving the filter plant have each a capacity of 400 gals per minute.

The filter plant was built adjoining the old pumping station and housed in a substantial 2-story brick structure, 25x65 ft., and two subsidence basins of concrete, each with a capacity of 70,000 gals., were located adjoining the filter building. Exhaust steam from the old reciprocating pumps and electric generators provides ample heating capacity for the new structure. The two filter units have each a capacity of 375,000 gals. Provision is made for doubling the size of the plant when and if required in the future. Wash water is supplied from an elevated steel tank, having a capacity of 20,000 gals.

The plant was placed in commission in December, 1921, and at this writing is functioning with an efficiency of 99.6 per cent.

A feature of interest in connection with this plant is the cheap fuel available in the shape of natural gas, which flows from the old water wells, now out of commission, but held in reserve as an emergency source of water supply. It is estimated that from 50 to 60 per cent of the fuel required by the boilers, generating steam for the old pumps and for the electric plant comes from these old wells, while coal from the railroad siding furnishes the balance of the fuel required. Natural gas from an old abandoned private well provides in part for the heating of the low service pumping station at the reservoir.

The total cost of the land purchased, the reservoir, low service pumping station, pipe lines, and filter plant complete approximated $140,000.

TERRE HAUTE WATER COMPANY USES MALLEABLE STREET VAULT COVERS TO STAND SHOCKS OF HEAVY TRUCK WHEELS

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., 634 Cherry St., Terre Haute, Ind.

Experience has shown conclusively that a gate valve in water mains in paved streets should be enclosed in a vault, pit or well with iron cover, so that repairs may be made without disturbing the paving. Occasionally, it is necessary to renew the packing in the stuffing box and sometimes a stem is broken while the valve is being closed or opened. The work of packing or making repairs is greatly facilitated if the valve is in a vault, pit or well. Then the tearing up of the paving is obviated.

It has been the policy, for many years, of the Terre Haute Water Works Co., to build brick vaults around valves in the street mains, with grey iron covers. The valves on hydrant branches are used so seldom that the ordinary street valve box is used on them. These vaults or wells have 9-in. brick walls laid in cement mortar; they are 5 ft. 6 ins. deep and 4 ft. 3 ins. inside diameter at the bottom, drawn in to a 22-in. round neck at the top. The first, or bottom course of brick is laid at a level slightly lower than the bottom of the main.

Formerly, and up to 1918, the Terre Haute Water Works Co. used a square grey iron frame and cover with a 21-in. opening; the upper portion of the frame was a flange 5 ins. wide supported by the brick neck of the vault and lying flush with the paving. The cover was ¾-in. thick with two ⅝x2¼-in. diagonal ribs.

The total weight of cover and frame was 224 lbs. The grey iron cover stood up under street traffic until the advent of auto trucks carrying loads of 5 tons and even more. Complaints were received from time to time of the breaking of the grey iron covers and it was thought best to improve upon the design and material.

The matter was taken up with Mr. Robert Koerner, the then City Engineer of Terre Haute, and Mr. Todd Zachary, Manager of the Standard Malleable Castings Co., Terre Haute, Ind. The result was a malleable frame and cover of the design shown herewith.

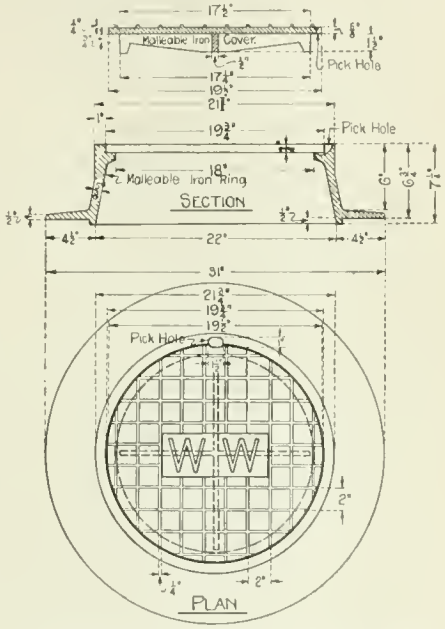
It will be seen that the design provides for the flange below the paving; less brick are required and danger of shocks to the flange from the wheels of trucks are eliminated. There is less surface exposed, although the opening in the frame is the same so far as practical use is concerned. The main advantage, however, lies in the greater tensile strength of malleable castings as compared to the ordinary or grey iron castings. The tensile strength of grey iron castings ranges from 14,000 lbs. to 25,000 lbs., while the minimum for malleable castings is 45,000 lbs.

The weight of the malleable frame and cover here shown is approximately 215 lbs. In December, 1921, the price in quantities was 8½ cents per pound, making the cost about $18.30 each. This price may be slightly lower at this time.

From a publication of the American Malleable Castings Association, Cleveland, Ohio, entitled "Certified Malleable Castings," the following statements are taken:

"The process of making Malleable Iron Castings may be briefly outlined as follows: It consists, first, of melting in an air furnace, open hearth, or electric furnace, a properly proportioned mixture of pig iron, with sprue or scrap castings from some previous heat, and possible additions of steel scrap. The molten metal has a silicon content low enough to force all of the carbon to remain combined in the resultant product and the consequence is that, after the iron has been cast in previously prepared molds, the castings will possess a white fracture with the accompanying hardness and brittleness incident to that condition. Such a material contains all of its carbon in the combined state. Examination of this white or "hard" iron under the microscope reveals the structure, consisting of a white ingredient, cementite, and a dark ingredient consisting of a solid solution of cementite in iron. Second, the subjecting of these castings to a heat treatment in suitably designed ovens where they are heated to redness for several days.

"Through this heat treatment, or "annealing,' the extremely hard compounds of iron and carbon are broken up into two very soft constituents, carbonless



DETAILS OF MALLEABLE IRON VALVE WELL RING AND COVER USED BY TERRE HAUTE WATER WORKS CO.

iron, or ferrite, the most ductile constituent in any iron product, and free carbon. Coincident with this transformation some of the carbon is removed from the castings, both factors serving to convert the hardest possible product into one which is soft yet very tenacious."

"The Association deemed it expedient that the Industry take up the research feature of its product and employed a metallurgical expert to do this work for those concerns which were unable to avail themselves of the services of a metallurgist permanently in their employ. The bars of secrecy were let down and co-operation became the order of the day. Each step in the process was carefully investigated and through visits to the various member companies the faults were eliminated and the product improved a

marked degree. Daily tests are made of the iron produced by each company and a uniformly high quality of output is demanded as the prime qualification for membership..

"Standard ⅝-in. test bars were made daily by each member from his regular heats and submitted to the metallurgist for test."

There is an advantage in Malleable Cast Iron in that while a casting, when subjected to the weather, will almost immediately cover itself with a thin coating of rust, the action of the elements seems to stop there and even after years of service, the weight and other characteristics remain unchanged.

In nearly three years' use of the Malleable casting frame and cover, there has not been one broken, although subject to the shocks incident to the passing over of heavily loaded trucks. On account of a number of small mines located just outside of Terre Haute, a large number of trucks are used for hauling coal to domestic consumers in the city, hence the frames and covers have been given a severe test. The tendency seems to be to enlarge the capacity of trucks and one can hardly suggest the ultimate limit that will be reached. Therefore, the Terre Haute Water Works Company has adopted the policy of replacing all broken valve vault frames and covers made of grey iron castings with malleable castings; for all new valve vaults malleable castings are used exclusively.

In water works practice, only the best material should be used. Some of the trucks in use in Terre Haute are hauling up to 9 tons of coal, including the weight of the truck, 5 tons; this means a total weight of 14 tons. The writer is of the opinion that in specifying frames and covers for valve vaults that malleable castings should be substituted for grey iron castings.

Malleable iron castings are fast replacing grey iron castings where service and strength are required. Records at the Standard Malleable Castings Company for the past year, show that the strength of the malleable iron produced at that plant has an average ultimate strength of 56,750 lbs. per square inch and an elongation of 17.25 per cent. The average ultimate strength of the highest grade of grey iron castings is in the neighborhood of 26,000 lbs. per square inch. This shows that malleable iron is twice as strong as grey iron. Therefore, as to strength and service, a malleable casting properly designed can weigh one-half that of a grey iron casting. This means considerable, both from the engineering standpoint and from the cost of production.

Of course, malleable and grey iron are not made in the same way. Malleable castings undergo a heat treament. Malleable easily absorbs sudden impacts and vibrations and thus is less liable to breaking. A grey iron casting cannot absorb shocks so well because of the ease with which it fractures.

THE EXTRAORDINARY HAZARDS OF METER READING

Consider the meter readers, who, unlike the lilies of the field, toil and sometimes spin, and also reap an astonishing harvest of injuries, says *The Travelers Standard*. At first thought, the reading of water, gas and electric meters appears to be an occupation in which the hazards are negligible. An examination of the accident records of public utilities will show, however, that meter readers are proportionately represented among the list of injured employees.

The meter reader has to use the streets more, perhaps, than any other utility employee. He is therefore subjected more to the hazards of street traffic, and to those associated with icy or otherwise slippery pavements; and eternal vigilance is the price he must pay, to be reasonably assured against injury.

He must next overcome canine objections to his entrance upon the premises he has to visit. This difficulty is more pronounced in small communities, where family pets are specially prevalent and where they are allowed greater freedom than in urban centers.

Having terrified, overpowered, or beguiled the dog, the meter reader is ready to enter the dwelling, and at this point he encounters another hazard, consisting in the decided contrast between the bright daylight that he is leaving, and the semi-gloom of the basement. This part of a house almost invarlably has poor natural lighting, and the artificial facilities usually consist of one electric light or one gas jet, near the furnace. The meter reader seldom stops to make use of these, because he invariably carries an electric flash light. To the householder, the illumination in the basement may appear to be adequate, because he seldom goes directly into the basement from out-of-doors, and so is not subjected to the sharp

contrast in lighting intensities. Furthermore, he is thoroughly familiar with local conditions, and knows, for example, that the third step on the stairs is worn at the edge, and that the fifth step is broken, and that the drain pipe, water pipes, or steam pipes are about forehead-high. He instinctively avoids the stair hazard, and goes about the basement in a bowed if not reverent attitude. A meter reader cannot do his work by instinct, and the obstacles he encounters do not always stimulate reverence. He usually flashes his electric torch along the path he takes, but as the field of illumination is limited, he often discovers overhead obstacles by the simple but unpleasant process of butting into them with his head. He tries to maintain a stooped position, and he means to investigate elevated objects as well as those on the floor; but the welts that he wears on his head show that he is not always successful.

Even though the stair treads are all present and in good condition, the housewife or servant sees no reason why she should not store a basket of potatoes on the basement steps where they will be handy; and a broom, a mop, and a scrup pail are usually present also. Among other things that meter readers have found on poorly-lighted basement stairs may be mentioned cans of syrup, jugs of cider or vinegar, dust pans, clothespins, grape baskets filled with stovepolishing materials, rakes, hoes, pitchforks, and lawn mowers. In fact the stairway easily becomes a catch-all,—a condition hazardous enough to the members of the family, but far more so to the casual visitor.

It would be decidedly impolitic for a public utility representative to criticize the housekeeping, or to point out that pools of water and slimy basement surfaces are unsanitary, though he can with propriety point out to the housewife that the whole family is endangered by using the stairway as a storehouse, or by allowing the basement floor to remain slippery. He seldom does so, however, because he is paid to read meters instead of preaching the gospel of safety. And so he goes on from house to house, knowing that he will meet these same conditions almost everywhere, and realizing that special care is his only safeguard.

Builders and contractors appear to exercise uncanny ingenuity in selecting inaccessible parts of the basement to install public utility meters. We have seen an electric switch-board and meter installed in a coal bin,—or perhaps the coal bin was built around the switch-board. When the bin is empty there is no inconvenience, but with the winter coal supply in, and the meter dials obscured by a coating of coal-dust and ashes, an accurate reading is a problem. We also recall a 2-family house in which the landlord stored the back porch storm inclosures and all the window screens in front of the gas meter. On one visit the meter reader worked half an hour to remove this material, and in doing this he got 3 slivers into his hands, and skinned 1 knuckle.

When the construction of the building permits, the meters are likely to be installed at a considerable elevation. Accurate meter readings are essential, because the utility company is in a good strategic position in case there is a complaint about the bill, provided the check-up reading shows the original one to be correct. Bearing in mind the poor lighting conditions, and the further fact that the dials are often covered with dust, it is plain that the meter man must get close up to the meter, to be sure of his reading. When the meter is installed at an elevation, the reader must find a ladder or improvise a scaffold or platform, out of boxes, barrels, or chairs of the loose-jointed type that are relegated to basements, in order to get a clear view of the meter. Many accidents are caused by such make-shift devices, and there appears to be no remedy available, other than to exert pressure on the proper authorities to change the locations of the meters.

Lack of forethought appears to be the only way to account for placing a laundry stove near a meter, or for locating a meter where the reader is likely to be burned by steam pipes.

Rubbish piles, with the hundred-and-one different things that accumulate in them, often cause accidents to meter readers. Garden implements, clothes racks, baskets, decrepit furniture, and broken boxes with upturned nails ever ready, are a few of the many things the meter man must be on the watch for. After reading the meter he must retrace his steps, and he is then subjected to the same hazards as on the entrance journey —though the danger is now somewhat reduced because he has learned something about the place, and his eyes have become more or less adjusted to the low illumination intensity.

NEW CENTRIFUGAL PUMPING INSTALLATION AT OXFORD, MICH.

By George Champe, Civil Engineer, 610 Nasby Bldg., Toledo, Ohio.

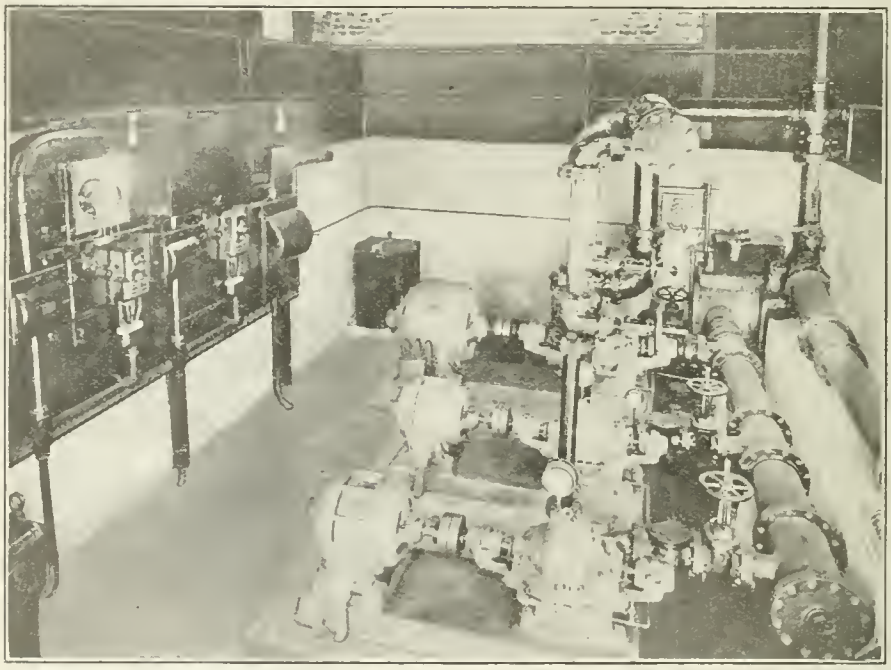
The new centrifugal pumping installation at Oxford, Michigan, is shown in the accompanying view.

The two pumps in the foreground are double suction, 2-stage, centrifugal pumps, with a capacity of 350 G. P. M. against 70 lbs., which is sufficient to fill, to overflowing the steel tank supported on a 100-ft. steel tower and located about three-quarters of a mile from the pump station on high ground in the village. Each pump is driven by a 30 h. p. 3-phase, 60-cycle, 220-volt, alternating current, squirrel cage motor. One pump is ordinarily in service. An altitude gauge, operated by the tank pressure, secures automatic operation of the pump, in service, so that no attendance is required. Previously under steam power operation, three attendants, in shifts, were required, for the 24-hour period.

In the background is seen an Underwriters' fire pump of 1,000 G. P. M. capacity against 100 lbs. manual control, for fire service. This pump is driven by a 100 h. p. slip ring, 3-phase, 60-cycle, 220-volt, alternating current motor.

No difficulty is experienced in the control of the altitude gauge on account of surge in the long pipe line between the pumps and the elevated tank.

From the standpoint of economy the installation is showing a reduction in operation of approximately 50 per cent.



VIEW OF NEW CENTRIFUGAL PUMPING INSTALLATION FOR VILLAGE OF OXFORD, MICH., WHICH REDUCES OPERATING EXPENSES 50 PERCENT.

"SHOOTING" WELLS TO INCREASE THE FLOW OF WATER

By S. R. Russell, C. E., Technical Representative, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.

(Editor's Note: The shooting of oil wells, by exploding a charge of nitroglycerin in the well to increase the flow of oil, is a common practice throughout the oil fields. Experienced blasters, with the necessary explosives and accessories, are employed by the oil operators and the methods of oil-well shooting are pretty well established. We are glad to present herewith an article by a technical expert on the shooting of water wells as published in The du Pont Magazine for November-December, 1921.)

Within recent years explosives have come into use for increasing the flow of

drilled water wells. The methods of blasting drilled water wells are much the same as those employed in the oil fields, but the desirability of blasting such a well should first be determined by careful study of its location, its drilling record, and the water supply it is designed to draw upon. While oil wells are usually located in segregated districts at some distance from a town, the drilled water well may be near a farm-house, in the town itself, or even, as in one case concerning which we were consulted, in the cellar of a metropolitan hotel. Whether it is safe to blast depends largely upon the proximity to buildings and the depth of the well. If the well is in a city close to or within large buildings, it may be dangerous to blast, lest the shattering of the rock underground weaken the foundations of the buildings, or flying fragments of rock do damage above ground. If the well is shallow, any risk there may be of injury to surrounding property is increased. However, wells within a few feet of houses have been blasted without the slightest damage and it is probably safe to say that if the size of the charge is proportioned to the depth of the well and the work is carefully done, blasting can be carried out in most places with little risk.

Factors to Be Considered

Whether it will be profitable to blast a drilled water well depends upon the quantity of water in the earth or rock surrounding the borehole, and the character of the formation. Just as it is a fallacy to suppose that there is plenty of water in the earth at any point if one only goes deep enough, it is unjustifiable to expect that blasting a dry drilled well will always make it yield water. Underground waters existing at varying depths, in varying quantities, and in varying degrees of accessibility determined by the climate of the region, the conformation of the surface, and the structure of the earth's crust. That portion of the rainfall which does not immediately evaporate or run off into surface streams sinks into the ground. A small part of it is retained by capillary attraction in the surface soil to be later returned to the atmosphere through direct evaporation or through plants, but the greater part seeps downward into deeper layers of soil or rock, often completely saturating them. The water in this saturated zone is called the ground water and is the great source of supply for lakes, springs and wells. Like surface water, although much more slowly, it is in constant movement from higher to lower levels, flowing evenly through layers of sand or gravel confined by relatively impervious strata, or in rock strata, trickling through the pores of the rock and along joint cracks, bedding planes, solution channels and other crevices. When the water bearing strata strike the surface, as often happens along hillsides or in valley bottoms, the water issues as a spring or forms a lake. It is, of course, to this ground water that wells are drilled. The United tSates Geological Survey has made studies of underground water supply in most sections of the country and can furnish maps and other information concerning the depth, abundance and composition of underground waters and the character of both the water-bearing strata and the strata between them and the surface which will be found of great value alike in selecting the well location and drilling the hole and in blasting to increase the flow of water.

Wells in Sand or Gravel

If a well is sunk into sand or gravel it generally produces water in direct proportion, first, to the quantity carried by the strata, as the water moves freely through all portions of such material, and second, to the angle of the strata, the steeper the dip of the water-bearing strata toward the bottom of the hole, the greater always the pressure and, consequently, the rapidity wtih which the water will rise in the hole. Firing a blast at the bottom of a well in sand or gravel would have practically no effect on the flow of the well; the sand or gravel would simply settle back after the explosion into its original place in the porous mass.

Wells in Water-Bearing Rock

If sunk into water-bearing rock, however, a well may draw only from the particular pores or crevices which it intersects and their tributary pores and fissures, and thus secure only a relatively small portion of the water carried by the whole stratum at that point. If passages could be opened into the borehole from the whole area of the surrounding rock, the flow of the well would be immediately increased. Here, therefore, is the function of explosives, for a heavy charge fired at the bottom of the well would increase the sectional area of the hole, making a collecting cavity for water, and would open up radiating fissures throughout a considerable area of the enclosing rock.

The methods of blasting drilled water wells are derived directly from oil-well shooting. The explosive is usually placed at the bottom of the hole. If a record of the hole has been kept by the driller, as should always be done, showing the kinds of material encountered in drilling, the depth and thickness of each successive layer and the point or points at which a water-bearing stratum was struck, this should be consulted by the blaster before deciding the location of the charge. It sometimes happens that a hole is drilled through a water-bearing area into a lower dry area and in such a case the shot should be fired, not at the

FIG. 1

bottom of the well, but at the level of the water-bearing rock.

The Explosive

Inasmuch as the greatest possible fracturing of the rock is desired, it is advisable to use a quick, powerful explosive and a heavy charge. The best explosive for the purpose is probably Du Pont Solidified Nitroglycerin, but, if this is not obtainable locally, Du Pont 60 per cent Straight Dynamite will also do satisfactory work, provided the column of water which may be standing in the well is not over 200 ft. high. The exact size of the charge is governed by the depth of the well, the nature of the rock to be blasted, and the proximity to buildings. For a well 100 ft. deep an efficient and safe charge would be from 100 to 200 lbs. of Solidified Nitroglycerin or from 150 to 300 lbs. of 60 per cent Straight Dynamite. For every additional 100 ft. this loading could be increased by about 100 lbs.

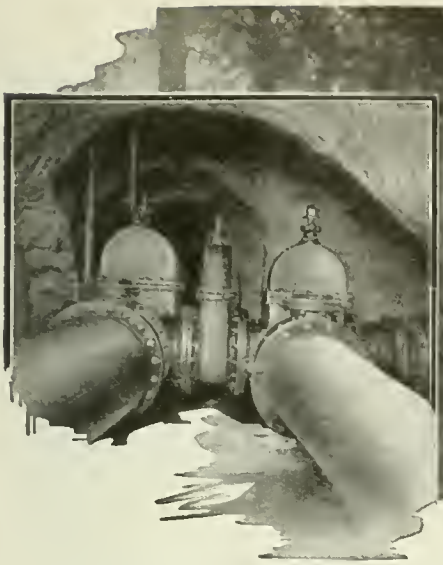
Seating the Charge

The cartridges are carefully packed in a cylindrical shell (Fig. 1), ranging usually from 3 to 5 ft. in length, made of tin or

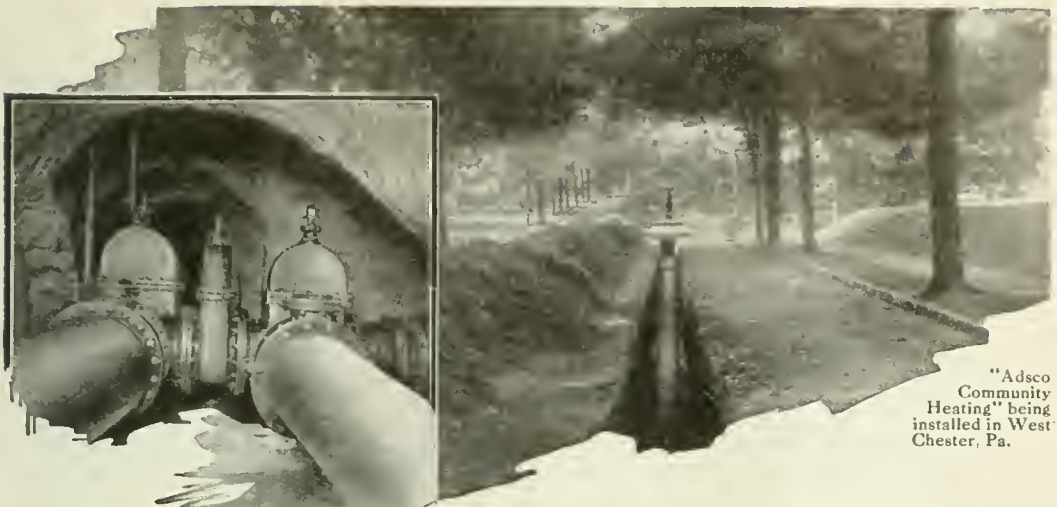
FIG. 2

galvanized iron drawn out to a point at the lower end to prevent it from catching in its descent down the hole, open at the upper end and provided with a wire handle or bail. Such a container can be easily made from an ordinary stovepipe. It should always be at least an inch smaller in diameter than the borehole. If there is standing water in the hole, as is usually the case, and the hole is of considerable depth, there should be an opening in the lower end of the shell, as shown in the illustration, so that the water may pass through the shell and equalize the pressure on the explosive.

When the shell is loaded, the bail is placed over a special hook (Fig. 2) on the end of a stout line and is slowly lowered down the hole. By a few motions of the line the hook can then be freed and drawn up. In shooting a very deep well, several shells may be necessary to hold the required charge. If so, they can be lowered successively and one allowed to rest on another. In case a charge is to be located at some distance up the hole instead of at the bottom, a shell provided with an anchor tip is used, that is, a tube about 1¼ ins. in diameter projecting a few inches from the lower end. A tin pipe long enough to reach to the bottom of the well is securely fitted over this tip



Steam Mains in tunnel at St. Paul, Minn. 110 feet underground.



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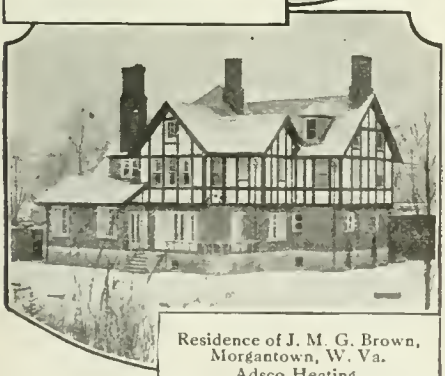

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and lowered into the hole ahead of the shell to serve as an anchor for it.

Exploding the Charge

The charge being seated, the next step is to explode it. This can be done by either the jack-squib (Fig. 3) or the electric squib (Fig. 4). both devised originally for oil-well shooting.

The jack-squib consists of galvanized pipe about 2 ins. in diameter and 36 ins.

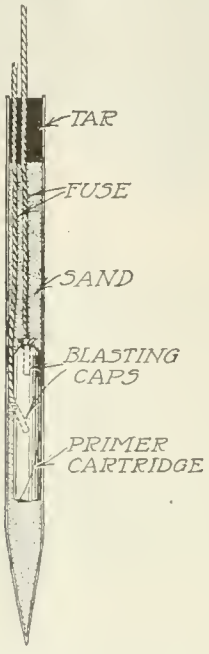


FIG 3

in length, pointed at the lower end, which is filled as follows: Sand is poured into the pipe to a depth of about 6 ins.; a cartridge of 60 per cent Straight Dynamite, primed with two No. 8 blasting caps and two fuses, is seated on the sand, and more sand is poured in until it fills the space around the cartridge and covers it to within 4 ins. of the top of the pipe. This remaining space is then filled with thick tar. This remaining space is then filled with a thick tar. As soon as the squib is prepared, both fuses are lighted, two being used in case one should fail, and the squib is dropped into the hole point down. The length of the fuse should be so calculated that the squib will explode about the time it strikes the charge and thus detonate it.

The electric squib of the oil-well shooter, which should not be confused with the Du Pont Electric Squib, is similar in construction to the jack-squib, but shorter and larger in diameter with a less sharply pointed end. It is usually about 5 ins. in diameter and 20 ins. long. It is filled to a depth of about 6 ins. with sand and then a primer charge consisting of from one to three cartridges of 60 per cent Stralght Dynamite is placed in the sand, one of the cartridges having been previously primed with a No. 8 Submarine Electric Blasting Cap. To the wires of this cap, at a point that will come well within the squib shell, are spliced No. 14-gauge copper wires long enough to reach to the bottom of the hole, and the splices are well taped. The remaining space is filled with sand topped with a layer of tar. This squib is carefully lowered by the wires until it rests upon the charge and is then fired by means of an electric blasting machine.

If the well has struck water there will probably be some standing water in the hole. Every foot of water in the hole exerts a pressure of 0.434 lbs. per 100 ft. high over a charge of explosives exerts a pressure of 43.4 lbs. on every sq. in. of the area of the charge. It is this pressure which makes it necessary to protect the detonator from moisture by placing it in a sand-filled and tar-sealed metal shell. As the pressure may

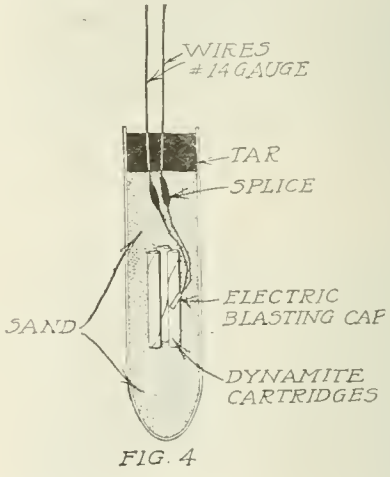
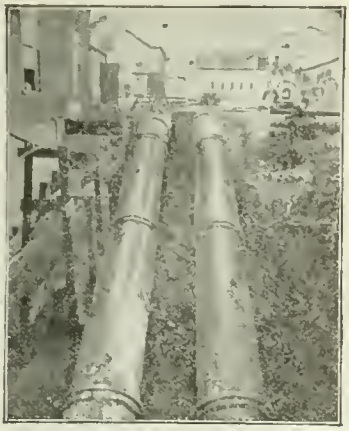


FIG. 4

tend to force out the nitroglycerin from the cartridges, it is important to fire the shot as quickly as possible after loading. All preliminary preparations such as removing objects within danger and notifying people should be completed before the explosive is lowered into the hole so that no time need be lost thereafter.

Effects of Blasting on the Well Casing

Most drilled wells contain a casing throughout a part or the whole of their



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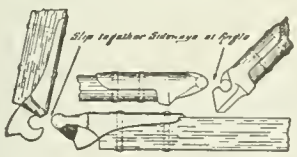

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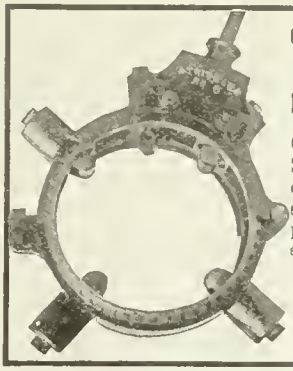

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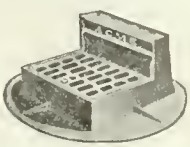

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depth; that is, a closely fitting iron pipe which has been inserted either to prevent sand, gravel or shale walls of the bore hole from caving or to shut off from the well seepage from water-bearing strata nearer the surface than the strata being drawn upon, which is apt to be polluted with organic matter. Exploding a heavy charge at the bottom of the well is likely to damage this casing, either blowing it out in fragments, which may do harm if allowed to fly into the air, or causing it to collapse within the borehole, or splitting it longitudinally along the seam.

To prevent the casing from flying into the air it is well to build a heavy grill work over the mouth of the hole. This should be securely anchored to the ground. It is hardly possible to prevent splitting the casing but this is not necessarily a serious result, for a casing that is merely split can easily be pulled out and replaced.

If the casing collapses, however, it is more difficult to remove. In a well 300 or 400 ft. deep there is less likelihood that the casing will be blown out or split than in a shallower well, but there is danger of collapse whatever the depth of the well. To prevent the casing from collapsing, the hole should be either full of water to the top or empty of water for 50 ft. below the bottom of the casing. This last would mean that the hole was cased through only a part of its length and that the explosive charge was seated at least 50 ft. below the casing. Suppose, for example, a well 100 ft. deep containing 50 ft. of casing from the surface down and 75 ft. of water. The explosion of the charge would probably cause the casing to collapse at the surface of the water. If the top of the water column was a few inches or a few feet below the casing, the collapse would probably occur at the bottom of the casing. If, however, the water was 50 ft. below it, there would probably be no collapse at all. So it is advisable before firing either to fill the hole full of water or to bale it out to a point 50 ft. below the bottom of the casing.

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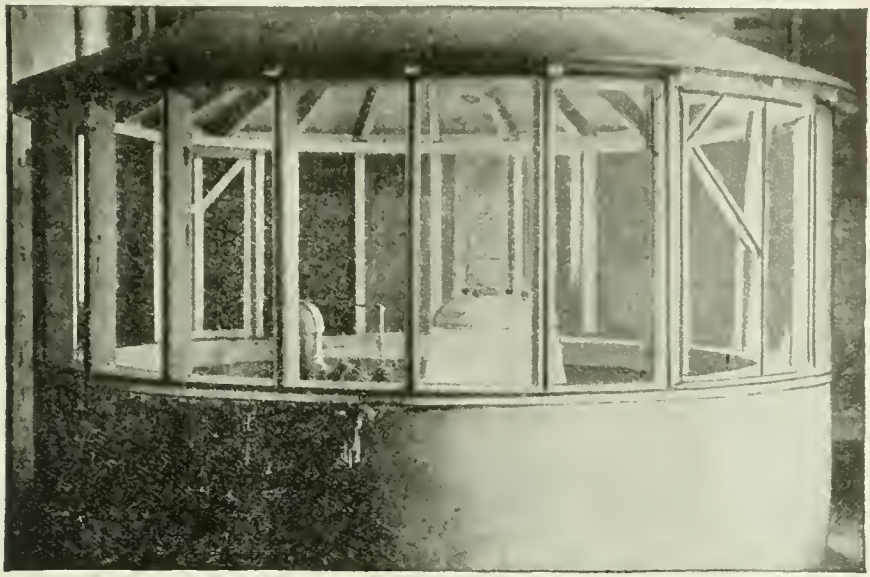
The current from generator to service pipe in the building or service connection is conveyed by flexible cable which is carried on the reel when not in use, final connections being made by universal clamps. The reel has commutator on one side connected to generator and carries 400 ft. of cable to connect to the nearest fire hydrant or main connection. The necessary amount of cable may be reeled out as required. The principal dimensions are as follows: Length over all, 10 ft.; height to top of instrument board, 4 ft. 6 ins.; height to top of radiator, 3 ft. 6 ins..

The first of these units was built for the City of St. Paul, Minn. The 37th Annual Report of the Board of Water Commissioners mentions the interesting saving of $18,000 in a single winter season, an amount several times the initial cost of the complete outfit.

Their report shows that there were 1,200 service connections thawed out, also many hydrants. The service connections were all successfully and rapidly thawed out by the thawing set in from 5 minutes to 15 minutes of thawing operation, the average being less than 10 minutes each, and the average cost of thawing each service pipe being $2.83. Whereas, in other years the old method required three to four men to dig a hole, thaw out and refill the hole at an average cost of $17.50 each, the saving on each service pipe thaw being $14.67 average. A material advantage also is that the street is not disturbed.

On the above basis. the city made a direct saving of about $18,000 in a single season with the further advantage of being equipped to do the service in a matter of a few hours instead of a long wait of sometimes days, as before, with the recurrent trouble and disadvantage of not having water over this long period. On account of the success of the first set the city obtained another to enable quick service all over the city.

Operation is taken care of by motor truck driver and helper. The outfit is manufactured by the Auto Engine Works, St. Paul, Minn.



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Construction News and Equipment

STEAM SHOVEL AND DRAGLINE COLLABORATE ON HEAVY SEWER EXCAVATION IN DETROIT

(Editor's Note: The use of steam shovels on sewer trenching is a familiar process and the same may be said of the dragline, but here is a case where the two types of equipment were used together, each performing the work for which it is best fitted. The machines supplemented each other very successfully.)

The dragline had been chosen to do the excavating on heavy sewer trenching in Detroit by the contractors, the Gass-Thurston Co., of Detroit, but the bucket would not dig into the hard yellow and blue clay through which the excavation was to be made. The contractors decided to place their 20-ton "B" Erie down in the hole to break the clay and loaded up to the dragline.

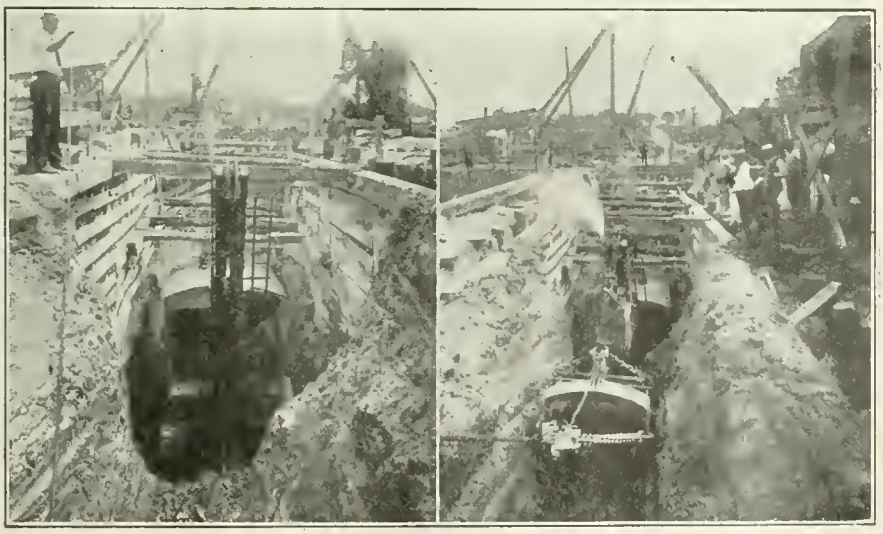
The sewer cut is 16 ft. wide, and varies in depth from 24 to 27 ft. The steam shovel loaded out the material on a bench straight ahead, 15 ft. above the bottom of the cut. The dragline machine then swung its bucket into the bench and removed the loose material, as shown by the accompanying views.

Working in this way, an average output of 350 cu. yds. per day was maintained, with about 400 cu. yds. as the best day's work. The speed of the dragline governed the output; as Mr. E. J. Gass, of the Gass-Thurston Company, writes: "The output of the steam shovel is governed by the speed of the dragline. If the shovel were loading out the excavating material direct, its output would be considerably greater."

EQUIPMENT PERFORMANCE ON ILLINOIS ROAD CONSTRUCTION IN 1921

By B. H. Piepcier, Engineer of Construction, Illinois Division of Highways, State House, Springfield, Ill.

Under normal seasonal conditions April is the first month in which pavement can be laid in Illinois, and this was the case in 1921. It is possible to get in approximately 8 months of work in this latitude. Considering the delays due to weather conditions and other causes, the maximum



STEAM SHOVEL AND DRAGLINE OPERATE EFFICIENTLY IN CONJUNCTION ON HEAVY SEWER EXCAVATION IN DETROIT.

time that any one mixer can be operated is approximately 120 days.

Out of the 102 independent pavers used in the State during 1921, one 21-E paver was operated 129 days; two were operated 121 days; two, 105 days, and the remainder less than 100 days. Fifty per cent was of the 4-bag or 21-E type. The average for all mixers of this type, considering all jobs and all days on which the mixer was operated, was 371 ft. per day. A few special records were made. In one instance a 28-E paver (9-bag) in 10½ hours laid 1,434 ft. of 16-ft. pavement, or 2,549.3 sq. yds. In another instance, two different contractors on night and day shift, with a 21-E paver (5-bag) laid approximately 2,500 sq. yds. The two contractors making this average also made several weeks' run of 1 mile per week, working double shifts.

Out of the 102 paving mixers operated in Illinois, 20 were charged by means of industrial railroad equipment; 34 by central proportioning plants—truck delivery; 12 central mixing plants—truck delivery; 8 from large storage piles upon the highway, and 28 from materials stored upon the subgrade.

During 1922 the specifications will not permit materials to be dumped on the subgrade.

The tendency of the contractors in the handling of their work in Illinois seems to be towards central proportioning plants with pneumatic-tired truck delivery. The popular mixer seems to be the 21-E, and the popular size truck is either the 1-ton Ford or the 2 or 2½-ton short-wheel base, pneumatic-tired truck.

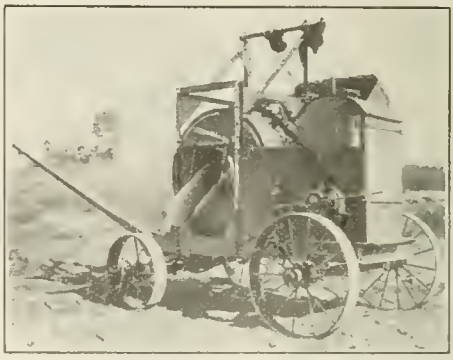
The use of industrial equipment for the delivery of materials has always proven its economy when topographic conditions were favorable.

The central mixing plant has proven to be both desirable and economical on a number or sections of work, where pneumatic-tired trucks were used and where the maximum haul did not exceed 2½ or 3 miles.

AUSTIN ADDS LINE OF DRUM MIXERS

The Austin Machinery Corporation, Chicago, has just announced another addition to its already extensive array of contractors' equipment—this time in the form of a complete line of popular-priced drum mixers.

Heretofore the Austin Mixers have been of the cube design, the mixing being accomplished without the aid of blades or paddles, simply by throwing the batch from plane to plane with a force varying according to the speed of revolution. This



AN AUSTIN DRUM MIXER.

necessitated materials and construction of unusual strength, which naturally would reflect in the price asked.

In the new drum type mixer, recourse is had to the customary elevating mechanism in the interior. The consequent freedom from unusual strain has enabled the Austin people to save on construction cost and thus to meet the demand for a moderately-priced mixer, equal to every ordinary requisite in the way of volume, rate and quality of output, working life, low maintenance cost, and manageability.

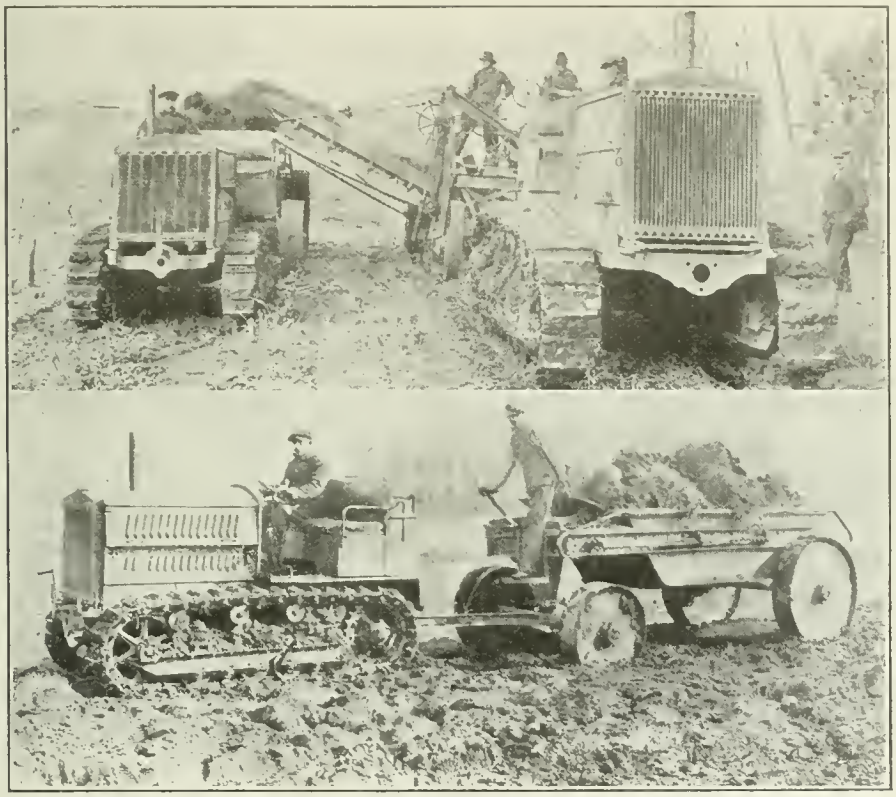
The same principle has been utilized to produce a secondary line of Austin Pavers. The mixers will be supplied in all standard sizes from ½-bag to 2 yds., and the paver in sizes from ½-yd. to 2 yds.

COMPLETELY MOTORIZED DIRT MOVING OUTFIT ON IOWA ROAD JOB

By E. M. Lagron, The Holt Manufacturing Co., Peoria, Ill.

The idea that good roads could not be built without a large corral filled with expensive live stock, and big camp furnishing quarters and rations for labor has been completely refuted during the last few years in many instances, but perhaps no more completely than on the Federal Aid Project No. 103, Delaware County, Iowa, job, which is being built by the Byers-Wilson Construction Co. The project has attracted more than ordinary interest among the highway officials and

contracting firms by reason of the fact that power for the entire operation is supplied by motor units instead of teams, and that there is no surplus of labor. The completely motorized program has revealed a great many economies which were heretofore not thought possible, but which have been conclusively demonstrated by the experience of this contracting firm. Not a horse or mule on the job, and no idle labor makes it an inspiration to witness this particular job and follow the operation chronologically from clearing the right-of-way through to the finished highway. Completeness and thoroughness of the work and the economy and speed which is made possible by the motorized system is self-evident to any one viewing the operation.



FULLY MOTORIZED DIRT MOVING OUTFIT ON IOWA ROAD JOB.
Top: 10-Ton "Caterpillar" Tractor and Russell Elevating Grader and 5-Ton "Caterpillar" with La Plant-Choate 6-Yd. All-Steel Wagon Working in Borrow Pit—Note Heavy Ribbon of Sod. Bottom: 5-Ton "Caterpillar" with 6-Yd. La Plant-Choate All-Steel Wagon. Haul 1,500 Ft.

Clearing

To insure unobstructed tile drainage, 1¼ and 1½ mile stretches of willow trees were pulled by the roots. For the work both the 5 and 10-ton tractors were used. The 10-ton pulled trees 6 Ins. to 36 Ins. in diameter out by the roots—thus absolutely eliminating future growth. Just as quickly as the trees, stumps and roots were pulled, the cable was changed from the 10-ton to the 5-ton, and the trees dragged off the right-of-way. While the smaller tractor was engaged in this work a second cable was being made fast to another tree, and the 10-ton was preparing to pull it out. In this way not a moment was lost, both tractors were working, and the trees and stumps coming out in quick time. Old bridges, piling and bents which had to give way in the natural march of progress to new concrete structures were likewise quickly and systematically removed.

On clearing, being force account work, the state saved considerable expense when comparing the results in the costs of doing the same work with common hand labor or other tedious slow methods. The contractor is likewise benefited

by being able to keep the road cleared well in advance of their grading operations. As most of this work was done on rainy days or on days immediately following rainy days, which would ordinarily have been time lost (the roads being too wet to work), this contracting firm was able to work nearly 100 per cent of the time. The tractor and crew were kept busy and no "lost time" charged up against profits.

Motorized Dirt Moving

The completely motorized elevating grader outfit with the tractors pulling both the elevating grader and the dump wagon presents many points of interest. Contractors and road officials have carefully watched the progress of the tractor and motor truck in this class of work, and to them the Byers-Wilson Construction Co. job is one of extreme importance, as it represents the solution to a problem which has caused no little worry, and which always has been more or less a source of grief to the dirt mover and road builder.

While the 10-ton was busy with an elevating grader doing the preliminary casting, the 5-ton with a blade grader was preparing the cut for the elevating grader, cutting down side banks, etc. The other 5-tons with either blade graders or wheel scrapers were doing finishing grading, cutting channels, removing heavy boulder or any one of the many odd jobs requiring power and endurance.

To appreciate fully the cost saving element of the completely motorized elevating grader outfit, requires a most careful analysis of time study results. To the casual observer of horse-drawn elevating grader outfits, it would appear that the rig is working to full capacity, This is a case of "snap judgment" and not substantiated by the facts. In the first place this appearance of "being busy" because there is always a team and a 1½-yd. dump wagon waiting to get under the belt is deceiving, as the fact must not be overlooked that it requires 10 to 15 seconds to load each 1½-yd dump wagon, and approximately 15 to 20 seconds are required to change wagons. In this way 40 to 60 per cent of the elevating grader's time is lost.

After exhaustive tests of equipment and material, and most careful scruting of cost sheets, the Byers-Wilson Construction Co. adopted the motorized outfit, but not until they had carefully investigation and realized by close study of the time lost with teams, the possible economy of the new method. The dump wagons which they are using on this job are a new product in the contracting and road building field. These wagons are all steel 6-yd. capacity, bottom dump. They have pressed steel wheels with 10-in. tires and heavy duty bearings.

The 5-ton tractor handles one of these wagons which is loaded by the elevating grader in approximately 45 seconds, and only 10 seconds are required to change wagons under the grader belt. The continuous loading of one 6-yd. wagon instead of several smaller units reduces the lost time factor from 50 to 18 per cent, and the time thus salvaged is utilized to advantage and profit in loading other 6-yd. wagons.

Additional time is saved traveling to the dump with one 6-yd. wagon as compared with teams and 1½-yd. wagons. Teams at their best will average 2¼ miles per hour (few teams can maintain this average day in and day out throughout the season.) The 5-ton tractor, with its multiple speed transmission, permits travel at either 5.7 miles per hour or 3 miles per hour, depending upon the load and ground conditions. The cost charts on the Byers-Wilson job show an average speed for the 5-ton with 6-yd. dump wagons of 4.35 miles per hour—almost twice as fast as teams. During the extreme heat of summer, the teams' efficiency is at low ebb, but the tractors' ability is not lessened.

Making Fills—Five Per cent Settlement

The manner in which the fills were made caused considerable comment, and attracted the attention of all who viewed the job. It was somewhat of a revelation to experienced dirt movers and road builders to realize the complete transition which was being enacted in this work.

The fill was built in layers of 6 ins. to 8 ins. Each 6-yd. load, when dumped, was knocked off and quickly spread with a pair of light mules and Mormon scraper. Each succeeding trip of the tractor and wagon with wide-rimmed wheels, both coming loaded and returning empty, rolled, packed and ironed out the fill until it was even more compact and harder than the old road had been. This was noticeable at once after heavy rains. On the old road, untouched by the grading outfit, traffic sunk in to the hubs; on this new grade just put in, the ruts did not exceed 2 to 5 ins. in depth.

The perfection of the fill was further added to by the action of the tractor grousers or cleats and the Mormon scraper. After rolling and packing by the wagons, the tractors would chew up the surface with their cleats. The surface thus loosened was again spread by the Mormon from the high spots into the low and again the surface was rolled and packed by the wide 10-in. tires of the 6-yd. steel wagon wheels. The result was a fill of uniform density, as solid and compact as if it had been rolled with a heavy steam roller.

At the beginning of this work, grade stakes were set for 10 per cent settlement. After the first 2 miles had been built, the shortage of dirt in the cuts was only additional proof of the rolling and packing of the fills. Accordingly the stakes were thereafter set for only 5 per cent settlement—the engineer being rightly of the opinion that fills put in with the tractor-wagon would have little or no initial settlement. These fills withstood the destroying effects of extremely heavy and frequent rains all fall.

Wintering Cost

Further evidence of the economy of the new system over that of horses and mules is found in the fact that the winter storage of the Byers-Wilson's equipment will cost them approximately $10 per month. This as compared with feed, corral, harness, stable boss and labor charges for the winter can be quickly appreciated.

Asked about future plans, Mr. Wilson says that they have just started, and that his company has conclusively established to its full satisfaction the economy and effectiveness of completely motorizing their outfits.

Contracts Awarded

ROADS AND STREETS.

Ala., Mobile—Hancock Bros., awarded contract for constr. of 4.6 miles Craft Hwy, connect'g Mobile and Chickasha; conc., conc. bridges, etc., at $165,000.

Ark., Pine Bluff—Fred Bennett, awarded contract to pave 36 blks. in Linden St. paving dist., at something over $100,000.

Cal., Avalon, Catalina Island—C. E. Garretson, 508 N. Comstock St., Whittier, awarded contract for impvt. of a number of streets in cent. sect. of town, at about $105,000.

Cal., Sacramento—Henry J. Kaiser, 1st National Bk. Bldg., Oakland, awarded contract for paving with concrete 17.6 miles state hwy. in Riverside Co. bet. Whitewater and Edom, at $298,011; Warren Construction Co., San Francisco, awarded contract for paving with asph. conc. 11.5 miles state hwy. in Riverside Co. bet. Edom and Indio, at $190,781.

Cal., San Bernardino—Henry J. Kaiser Co., San Francisco, awarded contract by St. Hwy. Comn. for bldg. section of state hwy. bet.. Whitewater and Edom at $298,000 and materials furnished by the state, $212,000. Road is to be 5 ins. thick, 16 ft. wide, reinf. conc.; Warren Constr. Co. awarded contract for section from Edom to Idio, asph. conc. 5 ins. thick and 16 ft. wide, at $190,800 and materials, $81,400.

Fla., Gainesville—Barber Fortin Co., Warren, O., awarded contract for constructing 12.6 miles rd., Alachua Co. from Burnett's Lake to Gainesville; Proj. 33; 8-in. compacted base; 3-in. bitum. macadam top, at $285,667.

Fla., Orlando—W. P. McDonald Constr. Co., Lakeland, Fla., awarded contract for constructing 8.59 mi, rd. Orange Co., at $228,040.

Fla., Palatka—Jno. F. Morgan Paving Co., Miami, Fla., awarded contract for constructing 12.8 miles rd. in Putnam Co., No. 18; 8-in. compacted base, 3-in. bitum. macadam top, at $335,830.

Fla., St. Petersburg—B. A. Inglis and C. F. Lytle, Birmingham, Ala., awarded contract for all of state

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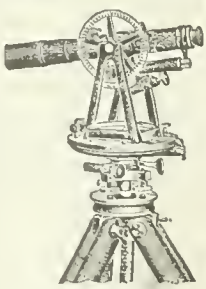

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road No. 1 betw. Columbia Co. line east to brick road, 42.78 miles, rein. conc., at $986,506; W. P. McDonald Constr. Co., Lakeland, contract for Proj. 13, Orange Co., Plymouth to Mt. Dora, 8.59 miles; 8-in. compacted rock, 3-in. asph., at $228,040; Jno. F. Morgan Paving Co., Miami, contract for Putnam Co. Proj. 18—Cisco to Volusia Co., line, 12.8 miles, 8-in. compacted base, 3-in. bitum. macadam top at $335,830; Barber Fortin Co., Warren, O., contr. for Proj. No. 33, Alachua Co.—Burnett's Lake to Gainesville 12.6 miles, 8-in. bitum. macadam top, at $285,667.

Ida., Lewiston—Fitzgerald & Stainton, Gt. Falls, Mont., awarded contract for approx. 10 miles road work at $100,000.

Ill., Elmhurst—Pronger & Black, Care E. Hancock, Engr., 2047 Ogden Ave., Chicago, awarded contract for grading, paving and curfing; also constructing sewers, here, at $114,000.

Ill., Springfield—Dept. Pub. Wks. & Bldgs., Div. of Hwys., awarded following contracts: Paving 3.02 mi. Route 12, Sec. 16, Marion Co. to Edwardsville Constr. Co., Edwardsville, at $64,861; 7.22 mi. Route 15, Sec. 16, Jefferson-Wayne Co., 5.59 mi. Route 15, Sec. 17, Wayne Co., 4.98 mi. Route 15, Sec. 18, Wayne Co., W. C. Neill Sons Co., Faribault, Minn., at $143,131, $115,325 and $103,869 respectively; 6.21 mi. Route 28, Sec. 7, Henry-Bureau Co., 5.68 mlles Route 28, Sec. 8, Bureau Co., J. J. Dunnegan Constr. Co., Shenandoah, Ia., at $116,945 and $114,-930 respectively, 5.79 mi. Route 31, Sect. 3, Adams Co., 5.7 mi. Route 31, Sec. 4, Adams Co. Eiff & Simons, 1013 Bwry., Quincy, $113,718 and $112,913, respectively. 2.09 mi. State Aid Route 10, Sec. E, Iroquois Co., H. Mullen & Sons, Kankakee, at $25,070, grading 7.21 mi. Route 13, Sec. 9-A, Saline Co., 6.32 mi., Sec. 10-A, Gallatin Co. and 6.42 mi. Route 13, Sec. 11-A, Gallatin Co., to L. Rich Constr. Co., Met. Bldg., E. St. Louis, at $18,363, $19,129 and $19,308 respectively; 0.3 mi. F. A. P. 8, Sec. V-3, Macoupin Co., M. R. Deyo & Co., Peoria, at $7,782.

Ind., Indianapolis—Pfizenmayer Constr. Co., Terre Haute, awarded contract for constr. of the Hessong Rd. which is to be a double course 5-mile conc. pavement from Crooked creek to county line, at $191,853; E. F. Smith, Indianapolis, awarded contr. for bridge construction at $21,662 and Standard Paving Co., Anderson, Ind., constr. for Collins Rd. work (1½ miles in length). Collins road work will be one-course conc. constr. Each of the 5 bridges will be rein. conc. Total amount of the contracts awarded is $248,800.

Ia., Clinton—Wright Constr. Co., Des Moines, awarded contract for paving west 17 mi. of Clinton Co. Lincoln Hwy. at $447,716.

Kans., Downs—A. R. Young & Co., Kansas City, Co., awarded contract for paving 25 blocks in resident and business districts, at approx. $160,000.

Ky., Frankfort—State Hwy. Comn., let following contracts for road construction: Langhorn & Langhorn, Huntington, W. Va., contract for constr. of 0.4 mi. road in Boyd Co. on Ashland-Greenup Rd.; brick construction, also contract for constr. of 7.9 mi. road in Greenup Co., bitum. macadam, at $215,-603; Louis de Gogets, Lexington, contract for constr. of 3.4 mile road on Lexington-Winchester pike, at $105,000.

La., Jonesboro—J. D. Harvey & Co., Memphis, Tenn., awarded contr. for constr. of 23.8 mi. of road from Winn Co. line to within 3 mi. of Ruston; gravel surf. with conc. culverts and bridges, at $125,583.

Mass., Ogdensburg—A. F. McConville, awarded contract to construct Schoharie County road, 10 miles long, at $266,000.

Minn., Austin—Cameron-Joyce Co., Keokuk, Ia., awarded contract for road construction work in Mower Co. at $109,084. Work includes jobs Nos. 2201, 2202, 2204, 2205, 2206 and 2207. Culverts awarded to H. F. Garbisch, Austin, at $9,474. Conc. monolithic, metal matl. to Lytle Corrugated Culvt. Co., 171 27th Ave., S. E., Minneapolis, at $3,856.

Minn., Duluth—O. R. J. Kapphahn Constr. Co., Chisholm, awarded contr. for paving Woodland Ave., at $100,785.

Mo., St. Joseph—Bryant Constr. Co., Waterloo, Ia., awarded contr. for paving Saxton-Easton Rd. and for resurfacing DeKalb Rd., at $213,775; Land Constr. Co., St. Joseph, awarded contr. for DeKalb road, at $90,008.

Miss., Laurel—Southern Paving Constr. Co., Chattanooga, awarded contract for paving streets here, at $100,000. Vitr. brick will be used.

Miss., Jackson—Dunn Constr. Co., Birmingham, Ala., and Jno. Gerken, Pensacola., awarded contract for paving N. President, N. Congress, Minerva and other streets; conc., at $100,000.

Mo., Jefferson City—Unit Constr. Co., Title Guaranty Bldg., St. Louis, Mo., awarded contract for 7.06 miles May Ferry Rd. FAP 80, at $243,931.

Mo., St. Joseph—Buchanan County and let road contracts as follows: Bryant Paving Co., Waterloo, for paving Saxton-Easton Rd., at $213,775; 7½ miles conc.; Land Constr. Co., St. Joseph, Mo., at $90,008, for resurfacing 10 miles DeKalb Rd.; asph. conc.

Neb., Omaha—Hugh Murphy Constr. Co., 402 Karback Bldg., Omaha, awarded contract for 111,260 sq. yds. conc. paving at $323,714.

N. Y., Malone—Wm. J. Semper, Watertown, awarded contract for constr. of Malone-Duane Center section of state hwy. (7.50 miles) at $233,000. Contract calls for bitum. construction.

N. C., Asheville—Hide & Baxter, awarded contracts for hwys. and bridge constr. work in Wilkes and Jones Cos., at $400,000. 16 miles penetrative macadam in Jones Co. will cost $22,480, and 6 miles reinf. conc. in Wilkes Co., $167,831. (Contractors located in Washington.)

N. C., Gastonia—Simmons Constr. Corp., Charlotte, awarded contract, also Carolina Contracting Co., Chester, S. C., at $800,000 for constr. of 40 miles hard surf. highways; asph. treating surface.

N. C., Raleigh—Following contracts let by N. C. State Hwy. Comn. Geer & Wilson, Rutherfordton, N. C., at $20,350, for constr. of 1 mile waterbound macadam rd. on Route 194, Avery Co. Proj. 801; Hyde & Baxter, Washington, D. C., for constr. of 15.76 miles waterbound macadam rd. with surf. treat. on routes 30 and 303 betw. Trenton and Craven Co. line, at $222,489; structs. to Jno. M. Ogden & Sons, Evington, Va., at $18,583, Jones Co. Proj. 245.

O., Euclid—Gould & Maybach, 823 E. 50th St., Clevelend, awarded contracts for grading, curbing and paving Ashville, Pinehurst, Edgewater, Kenwood, Oakleigh, Woodview, Edgemore, Elbury and Edgehill Sts.; brick, at $201,631; Beverly Hills Dr. to F. B. Stein, Euclid, at $30,571; sewers and water mains in Seabrook, Lakemont and Lamb Aves., Elsemere, Hawthorne and Cambridge Drives, to A. C. Hattendorf, 3601 6th Ave., East Cleveland, A. J. Galvin, Lennox Bldg., Cleveland, and J. B. Lyon, 1852 Rudwick Rd., Cleveland, at $12,707, $14,091 and $5,933, respectively.

O., Warren—V. Olson Contg. Co., 505 Mahoning Bank Bldg., Youngstown, awarded contract for grading, curbing and repaving 3,925 ft. E. Market St.; Metropolitan brick, asph. filler on conc., at $123,612.

Okla., Oklahoma City—State Hwy. Dept. let road contracts as follows: Keliher Constr. Co., Little Rock, Ark., at $92,664 for constructing conc. road from Broken Arrow to Wagoner Co. line; Tibbets & Pleasant, Tulsa, at $91,908, for conc. rd. from Rogers Co. line eastward toward Tulsa.

Okla., Pauls Valley—Standard Paving Co., Tulsa, Okla., awarded contr. for brick paving in Dists. 12, 15 and 16, at $198,000.

Ore., Seaside—J. H. Tilman Co., awarded contract for paving several streets, at $159,000.

Pa., Ebensburg—Anderson Constr. Co., Parnassus, awarded contr. for construction of 32,669 ft. state hwy., Clearfield and Ind. Cos., at $267.452.

Pa., Wilkes-Barre—M. Rosato & Son Co., Inc., W. Scranton, awarded contract for paving hwy. betw. Carbondale and Clifford with reinf. conc., at $193,000.

S. C., Hartsville—Georgia Engrg. Wks., Augusta, Ga., awarded contract to construct 50,000 cu. yds. paving; 40,000 ft. curb and beaders, etc., $200,000 available.

S. C., Sumter—Adams-Evans Constr. Co., Jacksonville, Fla., awarded contract to construct 3.1 miles hard surfaced roads on Sumter-Bishopville and Sumter-Manning highways; asph. conc. constr. Total cost, including grading, $151,946.

Tex., Dallas—Scarborough, Smith & Davis, awarded contract for construction of Irving Coppell Rd.; contr. for the surfacing awarded to Texas Rd. Co.; bridges to Andrew Jackson. Total cost of work,

$300,000. Rd. will be built with crush. rock foundation and 1-in. cold mix asph. top from end of conc. rd. in W. Dallas to Irving, abt. 8 miles. From Irving to Sowers to Co. line east of Coppell, 16 mi. rd., constr. will be of gravel.

Tex., Dallas—Miller Constr. Co., Sioux City, Ia., awarded contr. for paving with asph., macadam and gravel surfacing 12.6 miles Preston Rd., and contract for bridges to A. Jackson, 424 Spring Ave. Total cost, $207,581.

Tex., Dallas—Smith Bros. Constr. Co., Dallas, awarded cont. for 12.2 miles asph. pike from city limits of Dallas to Mesquite and from Kaufman Co. line back toward Dallas almost 2 miles, known as East Pike, at $261,719.

Tex., Eastland—Smith Bros., Crockett, awarded contract for constr. of Bankhead Hwy. through Eastland Co., Cisco to Eastland and Ranger, about 21 miles long, at approx. $806,000.

Tex., El Paso—El Paso Bitulithic Co., awarded contract for paving San Eljario Rd., St. Hwy. 33, Job 72-C, 5.54 miles, at $149,668.

Tex., Fredericksburg—Gordon Auvus, Winnsboro, Tex., awarded contr. to construct grading and draing. structs., including bridges, at $100,000.

Tex., Greenville—Board of Permanent Rd. Comrs. Hunt Co., care A. D. Buck, Constr. Supt., awarded contract for grading, surfacing and bridging 9.66 miles St. Hwy. No. 1, F. A. P. 188, at $231,289.

Tex., Hondo—Kuykendall & Shelton, Temple, Tex., awarded contract to construct 13.4 miles gravel rd. with asph. topping, at $226,000.

Utah, Salt Lake City—Moran Paving Co., Felt Bldg., awarded contr. for curbing and guttering Dist. 24, 3rd to 11th Aves., and from H to N Sts., at $149,065.

Va., Williamsburg—S. E. Lee Constr. Co., Emporia, Va., awarded contract for constructing 5.36 miles 18-ft. conc. pavement on State Rd. No. 9, bet. Williamsburg and Lee Hall in James City and Warwick, at $152,219.

Wash., Olympia—Frank Morgan, Buckley, awarded contract for clearing, grading, draining and surfacing with crushed rock, 3 miles Navy Yd. Hwy. bet. Tidewater Crk. and Charleston, Kitsap Co., at $79,584; clearing, grading and surfacing with gravel 3.1 miles, No. Bank Hwy., bet. Cooks and Underwood, to Hans Pederson Constr. Co., Seattle, at $54,993; surfacing with gravel 1 mile of No. Bank Hwy. from Stevenson west, Skamania Co. to Voyle & Lindsay, Stevenson, at $3,827; clearing, grading and draining 2 mi. Ocean Beach Hwy. bet. Naselle and Johnson's Landing, Pacific Co. to Pentillo & Petervo Co., Naselle, at $26,138; clearing, grading, draining and surfacing with gravel 9 miles Olympia Hwy. bet. Beaver and Forks, Clallam Co. to Reinseth & Co., Everett, at $70,732.

W. Va., Charleston—State Road Comn. let following road contracts: Joe Carola, Roncerverte, W. Va., 4.6 mi. Pickaway-Second Crk. Rd., at $87,396, also contr. for 14.5 mi. Rainelle-Rupert Rd., Greenbrier Co., at $269,186; Ederbach Constr. Co., Pomeroy, O., 1.8 mi. West Hamlin-Salt lock Rd., Lincoln & Cabell Cos., at $161,404; A. L. Nickolich, Fairmont, W. Va., 5 miles Friendly-Bens Run Rd., Tyler Co., Proj. 3080, at $38,573; McClain Constr. Co., Bellaire, O., 0.9 mi. River Rd., Hancock Co., at $30,162; Lookout Constr. Co., Victor, W. Va., for constr. of 3.5 mi. Canvas to Summersville Rd., Nicholas Co., at $31,778; Dayton & Co., Elkins, W. Va., 3 mi. Philippi-Belington Rd., at $23,816 for constr. of 1.1 mi. Junior to Randolph Co. line rd., both Barbour Co., at $72,471 and $28,816 respectively; Smith & Quinn, Parkersburg, W. Va., 2 miles St. Mary's-Grape Island Rd., Pleasants Co., at $16,333; Julian Constr. Co., Glen Jean, W. Va., 5 miles Beckley-Harper Rd., Raleigh Co., at $104,437; W. C. Markle, Clay, 3 miles Clay Courthouse-Hartland Rd., Clay Co., at $45,606; A. C. Grideli Co., Berwyn, 2½ mi. Elizabeth-Palestine Rd. Wirt Co., at $25,072; W. U. & J. T. Gephart, Williamsport, Pa., for constr. of 8.6 mi. Elkins-Burlington Rd., Randolph Co., at $274,000; Geo. L. Pence, Huntington, W. Va., for constr. of 0.6 miles Hamlin-West Hamlin Rd., at $26,238.

SEWERAGE AND SEWAGE TREATMENT

Fla., Monticello—Sullivan, Long & Hagerty, Bessemer, Ala., award. contract to install sewerage system at $34,897.

Ga., Atlanta—McDougald Constr. Co., awarded contract by Citizens' Trust Co. to install sewerage facilities and pave walks and streets in 33-acre tract, at $48,000.

Ill., Bellwood—H. Rees & Son, Quincy, awarded contract for new system of sewers and pump pit, at $125,000.

Ind., Brazil—Foulks Constr. Co., 705 Ohio St., Terre Haute, Ind., awarded contract for sewage treat. plant, Imhoff tanks, sprinkling filters, sludge beds, etc., at $75,000.

Md., Baltimore—Aiello Constr. Co., Knickerbocker Bldg., awarded contract for sewer contracts 48, 185 and 186, at $22,648, $25,929, and $18,031, respectively; Contr. 203-06 to Baltimore Asphalt Blk. & Tile Co., 1320 N. Monroe St., at $32,166.

Mich., Dearborn—J. Porath, 34 McGraw Bldg., Detroit, awarded contract for East Side storm water sewer, 3 ft. 6-in. to 4 ft. 9-in. conc. or brick, at $32,831.

Mich., Detroit—R. D. Baker, 1631 Elmhurst Ave., contr. for lateral sewer 3586, at $25,500; Six Mile Rd. sewer, Sec. 4, to J. A. Mercier, 216 Hammond Bldg., at $290,350.

Minn, Mankato — Hammen & Co., Mankato, awarded contract for sewers and appurts. in Sewer Dist. 3, at $74,915. 385 lin. ft. 18-in. cast iron pipe, 33,541 lin. ft. 8 to 18 ins. V. C. P., 107 hrk. manholes, 84 V. C. P. chimney connections.

Mo, Columbia—C J. McCoy Constr Co., Emporia, Kans., awarded contr. for sewage disposal plant here, complete, at $14,500; sprinkler filter complete, at $47,600; sludge filter complete, $2,000; secondary settling tank, $2,000; conc. bulkhead, $500.

N. J., Newark—Shevlin Engrg. Co., Inc., 110 W. 34th St., New York C., awarded contract for sewage screening machy. installed at Newark Bay Pumping Sta., Port Newark, at $55,660.

N. J., Rutherford—L. B. Harrison & Co., Island Market, Paterson and J. T. White Co., 52 Lexington Ave., Passaic, awarded contracts for Rutherford-Union Branch Intercepting Sewer, here, at $116,287.

N. Y. New York—P. McGovern, 50 E. 42nd St., awarded contract for sewer in 26th St. from bulkhead line of East River to Madison Ave., etc., at $580,391; altering and improving sewer in W. 20th St. to J. Burns, 103 E. 125th St., at $18,365; repairing 15-in. vitr. sewer in East 101st St. to J. V. Timoney Co., 220 E. 201st St., at $2,425.

N. Y., Painted Post—National Constr. Co., Inc., 2218 Chestnut St., Phila., awarded contract for 4½ miles storm and san. sewers, at $63,000.

N. Y., Schenectady—E. P. Edgar, 116 Mohawk St., awarded contract for intercepting sewer, at $76,194; sewers in Bird Pl., Pious Alley, Frank, Hendricks and Bradley Sts., to O. Russo, 942 Crane St., at $2,773.

O., Columbus—Federal Paving Co., 724 Linwood Ave., awarded contr. for 3 miles 15-36 in. joint intercepting sewer in Clinton Dist. 2 at $86,517.

O., Warren—F. George, 1657 Mahoning Ave., Youngstown, awarded contract for laying 3,300 ft. 36-in. segmental blk. and 8,844 ft. 8-24 in. vitr. sewer in South Pine St. and River Ave. outlet, at $63.734.

Okla, Pauls Valley—Gibson & Mitchell, Pauls Valley, awarded contract for constr. of storm sewers, at $45,000.

Okla, Pawhuska—Dahlstrom Impvt. Co., Tulsa, Okla., awarded contr. to constr. sewage disposal plant, at $39,400.

Tex., Breckenridge—McKenzie Constr. Co., San Antonio, Tex., awarded contract to construct 14 miles sewer lines; install disposal plant with 500,000-gal. daily capy. Imhoff tank, at $236,000.

Tex., Magnolia Park (P. O. Houston)—Houston Construction Co. awarded contract to install sewer system; lay 8 to 15 in. mains; construct laterals, at about $600,000.

Wis., Kenosha—Markus Thomson, Kenosha, awarded contract for 10,200 ft. 12 to 48-in. sewers, 250 ft. 6-in. sewer stubs and 40 conc. manholes in Allendale and Lake View subdivs., at $48,460.

Wis., Kenosha—M. Thomson, 1020 Salem Ave., awarded contract for monolithic and vitr. sewers in Lakewood, Durkee, Sherman and Arlington Aves., Exchange and Plymouth Sts., Kenwood, Beverly and Belmont Places, at $46,206.

Wis., Milwaukee—DuPont Engrg. Co., Wilmington, Del., awarded contract for sedimentation and

aeration tanks, in connection with disposal plant on Jones Island, at $726,188.

WATER SUPPLY AND PURIFICATION

Cal., Fullerton—P. H. Ehlers, 1959 N. Raymond Ave., Pasadena, awarded contract for rein. conc. reservoir, at $49,350.

Cal., San Diego—G. E. Engineering Co., Inc., 449 42nd St., New York City, awarded contract for constr. of water, gas, sewer and underground elec. systems at naval hospital, at $52,400.

Ont., Toronto—Gordon Thompson, 40 Jarvis St., Toronto, awarded contract for constr. of 6-in. water mains costing $32,000 for York Twp.

Ind., Marion—C. W. Bailey, Marion, awarded contract for alterations in pumping station and new 5,000,000-gal. steam pump, at $50,000.

Ia., Storm Lake—Pittsburgh-Des Moines Steel Co., Tuttle and SW. 10th, Des Moines, awarded contract for 250,000-gal. steel tank on 100 ft. tower, at $14,250.

Kans., Hoxie—Reed & Wheelock, Clay Center, awarded contract for water work system, 21,270 lin. ft., 4, 6 and 8-in. cast iron pipe, 40,000-gal. tank, 100-ft. tower, etc., at $31,068.

Kans., Marion—Burt & Tripp, Hutchinson, awarded contract for Sec. 1, constr. of bldg. and dam, Sec. 2, pumps and motors and Sec. 3, filter equipt., at $54,997.

Mich., Benton Harbor—Jno. Allmendinger, awarded contract for construction of city new water plant which will include filtr. sys., permitting use of St. Joseph river water. First work to be done is constr. of 2 immense reservoir tanks; one to be a clear water basin holding 770,000 gals. of water, and the other a coagulating tank holding 330,000 gals. The contractor will be paid $5,200 for work of constr., supervision, etc. Net total cost will be about $50,000. Entire work will be under general supervision of Pearse, Greeley & Hansen, Cons. Engrs., Chicago, Ill.

N. C., Rocky Point—J. B. McCrary Engrg. Corp., Atlanta, Ga., awarded contract for extension of water mains and constr. of filter plant; daily capy. 500,000 gals.; purchased two 200-G. P. M. high head upmps and two 200 G. P. M. low head pumps; will install; approx. $30,000. Williamson, Carroll & Saunders, Engrs., National Bank Bldg., Charlottesville, Va.

N. D., Fargo—Norwood Engineering Co., Florence, Mass., awarded contr. for equipping two additional filter units at filtr. plant, at $27,000.

O., Cleveland—Babcack & Wilcox Co., Guardian Bldg., awarded contr. for furnishing 4 water tube boilers at $76,519; Hanford-Riley Stoker Co., Swetland Bldg., contr. for mechanical stokers, at $42,490.

Okla., Broken Bow—Ladd Constr. Co., 716 Scarritt Bldg., Kansas City, Mo., awarded contract for water works system and filtration plant, at $120,000.

Okla., Fairfax—Ajax Constr. Co., Lawton, awarded contract for improving water works, sewers and disposal plant, at $58,776.

Pa., Philadelphia—W. K. Mitchell & Co., 2940 Ellsworth St., awarded contract for piping at Queen's Lane and Larner's Point pumping stations, at $11,833; steel connecting flues and economizers to Phila. Tank & Stack Wks., Phila., at $7,388; general constr. of foundations for Belmont pumping station to Mitchell-Houseworth Co., 30th and Lehigh Aves., at $21,747.

Utah, Salem—F. S. Whitney, Eureka, awarded contract for 8,000-ft. 4-5-in. cast iron gravity flow line, 30,000 ft. 1½-4-in. steel pipe and 75,000-gal. concrete reservoir, at $20,000.

Va., Charlottesville—W. T. Thurston & Co., Merchants National Bank Bldg., Richmond, awarded contract for 2,000,000-gal. rein. conc. filter, 1,000,000-gal. rein. conc. reservoir, 5,000-ft. 16-in. concrete pipe, etc., at $130,000.

Wash., Walla Walla—Williamette Iron Works, Portland, Ore., awarded contract for furnishing 11,250 ft. 24-in. steel water pipe with 5-16-in. wall, at $50,062. Pipe will be used in extending city's water supply system.

Prospective Work

ROADS AND STREETS

Ariz., Nogales—Work on new 1,000-mile Mexico Hwy., will start in March, according to Gen. Angel Flores.

Ark., Batesville—Contract will be let about Mch. 15, for road work (native gravel) in No. Ark. Impvt. Dist. No. 2, of Independence, Izard and Fulton counties. Work will be let in 4 sections, 20 miles each. Plans call for conc. and steel bridges. Est. cost $600,000. E. C. Parsons, Batesville, Chrmn. Board of Commrs., E. E. Mashburn, Cotton Plant, Engr.

Cal., Glendale—About 50 street impvts. coming up in Glendale. City Engr. C. L. Hill states that two or three will be advertised for bids each week until program is completed. Many are good sized jobs.

Cal., Huntington Pk.—City Engr. H. McCurdy, Pacific Elec. Bldg., Los Angeles, instructed by City Trustees to prepare plans and specfs. for paving Randolph St., east to west city limits, a little over a mile, with 6-in. asph. concrete.

Cal., Merced—J. F. McSwain, former City Engr. of Merced, preparing plans and specfs. for about 20 to 22 miles oil macadam pavement, 5 to 6 ins. thick, to be built on roads leading from back country to Livingston and Atwater on state hwy. in northern part of Merced Co. Work will be done under Rd. Dist. Impvt. Act of 1907. Cost about $250,000. Plans completed in about 45 days.

Cal., Pomona—Proceedings being started and bids will be received some time in April for improving 7 streets, involving about 473,442 sq. ft. 5-in. conc. pavement and 6,600 lin. ft. cem. curb. F. C. Froehide, City Engr.

Cal., Sacramento—Chrmn. N. R. Darlington, of the Calif. Hwy. Comn., announces that plans of Comn. call for impvt. of Pacific Hwy. from Dunsmuir, Cal., to Oregon state line, at cost of more than a million dollars. Section from Dunsmuir to Weed, 21 miles, has been graded and will be paved throughout this present year; section from Weed to Gazelle, 11 miles, will be partly graded and surfaced and whole will be graded in near future. Bet. Gazelle and Yreka road has not been improved (18 miles), but Comn. is considering expendt. of $200,000 on it. From Yreka to Ore. line, 25 miles, Comn. has graded and graveled and that portion bet. Klamath River and Ore. line will be widened and paved at cost of $250,000.

Conn., Bridgeport—Streets and Sidewalk Comn., plans to expend $200,000 for general and special grading work. J. A. McElroy, City Engr.

Conn., Manchester—City contemplates paving Main St.—Charter Oak to Center Sts.—concs., $100,000. J. F. Bowen, Town Hall, Engr.

Fla., Clearwater—Pinellas Co. contemplates issuance of $1,000,000 bonds for widening present brick paved roads.

Fla., Tavares—$600,000 bonds have been sold. Proceeds will be used for constr. of 70 miles of sand clay rds. and rebldg. of 50 miles old roads of Districts Nos. 3, 4 and 5, in this county. This will include rd. from Astor to Polk Co. line, via Umatalla, Eustis, Tavares, Clermont and So. Clermont, thence to Groveland to Auburndale. Rd. will also be built from Eustis east through Paisley to the St. John's River; one along shores of Lakes Dora and Eustis; also lake drive around north shore of Lake Mineola to Clermont.

Ida., Boise—More than $2,200,000 will be expended by state in Northern Idaho, according to announcement made by Commr. W. J. Hall. Arrangements completed to finish 4 miles north and south hwy. just north of Sandpoint. State also making survey of Laclede Hill bet. Sandpoint and 4 miles of this will be built this summer by county under state specifications and supervision. On No. Pacific Rd., Lookout sect., National Mill above Mullan to Mont. line (5 mi.), will be completed.

Ill., Belleville—Tentative plans for 5 hard road projects in St. Clair Co., Ill., announced by D. O. Thomas, Supt. of Hwys.: Approx. cost of high-

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, Jamee P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

ways, $25,000, $100,000, $140,000, $180,000 and $420,000.

Ill., Brookfield—Will open bids about April for paving various streets here; rein. conc., $20,000. E. Hancock, 2047 Ogden Ave., Chicago, Cons. Engr.

Ill., Chicago—Bd. Local Impvts., 207 City Hall, considering paving Western Ave., 71st to 95th Sts., $495,001; from 95th to 111th Sts., $331,000; 111th to 119th Sts., $142,000. Will also take bids in near future for widening Western Ave.; Lawrence Ave. to W. 31st St. C. D. Hill, Chief Engr.

Ill., Joliet—Will County making plans for conc. paving on various roads, $91,500. W. H. Smith, Court House, Engr.

Ia., Charles City—Plans to pave 6-mile road in Floyd Co. Engr., G. Elhott, Co. Aud. T. B. Russell. $150,000.

Kans., Hutchinson—25 miles gravel rd. will be built across Pawnee Co., Larned to Burdett. Ests. of cost indicate road will cost about $125,000. Fed. and State Aid.

Kans., Topeka—State Hwy. Comn. placed $1,428,112 in balance against unemployment in state by granting that amt. of fed. aid for hwy. constr. This means a total of $2,856,225 will be expended at once on road constr. in Kansas. Total mileage of hard surfaced rds. projected in aid granted, is 116.4 miles. This includes 7 large bridges and 1,100 ft. trestle work. Shawnee Co. receives $180,000 in Fed. aid for use immediately in constr. of 15 mi. hard surfacing (probably concrete.)

Ky., Louisville—City will soon ask bids for re-bldg. and asph. paving on portions of 7th, 8th, 18th, Portland, 28th, Finzer, Baxter, Fehr and Hill Sts., $130,000. A. A. Krieger, City Engr.

La., New Orleans—Commission Council adopted tentative paving program for 1922, which if carried out, will call for expendt. of $500,000 on part of city and $2,200,000 of prop. owners' money. Ord. introduced by Pub. Prop. Commr. Wilbert Black calls for new paving on 21 streets and repaving sections of 6 additional ones.

La., New Roads—Pointe Coupee Parish (J. A. Oubre, Secy.), will sell $73,000 Road Dist. No. 6; $64,500 Rd. Dist. No. 1, $115,000 Rd. Dist. No. 2 and $47,500 Rd. Dist. No. 4, road construction bonds.

Mass., N. Attleboro—Constr. of approx. 80 miles state hwy. to cost in neighborhood of $2,500,000, is proposed during 1922 by State Dept. of Public Works, Boston Dept., will undertake reconstr. of 2 sects. of Providence-Boston route. In Norwood it is planned to build a little more than a mile of high class concrete road from Westwood line southerly to Norwood. In Walpole, Norfolk and Wrentham, about 6½ mi. also of concrete, will be constructed from Walpole line southerly to Wrentham.

Mich., Benton Harbor—City will pave Empire Ave. W. and E. Main, Territorial, Fair Aves. and several other streets. Opening of Wall St. estimated to cost $100,000, will in all probability be carried out.

Mich., Detroit—Wayne County expects to lay 50 miles of highway, work to start in spring. Concrete surface at cost of $2,000,000. Replacement of dilapidated bridges will cost $1,000,000.

Mich., St. Ignace (Mackinac Co.)—State Hwy. Comn. plans approx. 225 miles new rd. constr. in 1922 in Mackinac, Schoolcraft and Chippewa Cos. H. I. Davis, Escanaba, Dist. Hwy. Commr., F. F. Rogers, St. Hwy. Commr., Lansing. Est. cost, $2,300,000.

Minn., St. Paul—Constr. of the $250,000 hwy. to South St. Paul and territory to south is virtually assured. Ord. passed to pave connecting link within city limits. Bd. Co. Commrs. have included, in this year's paving fund money to assist So. St. Paul with continuation of paving and also to build new road of 6 miles into Rich Valley. Bd. also passed by Council calls for paving State St., Oakland Ave. to S. Robert Sts.; S. Robert St.; Gates to south city limits. Est. cost of paving, which is to be brick laid flat, is $47,432.

Mo., Jefferson City—State Hwy. Comn. has approved plans on about 250 miles hwy. representing expendt. of more than $2,000,000, according to information from state hwy. dept. St. Bd. approved state aid projects, begun by former Comn., representing 54.49 miles of hyw. at cost of $272,468, snf. approved for constr. 55.86 mi. state aid projects at cost of $348,883. Fed. aid proj. approved total 136.69 miles at cost of $1,388,875.

Mont., Great Falls—Will gravel surface 15 miles of road from Sun River through Fort Shaw, Simms to Knox Hill. Engr. E. T. Harlow, St. Hwy. Comn. Jesse R. Bennett, Co. Commr., Cascade Co., $112,000.

Neb., Omaha—Expendt. of more than $1,000,000 for paving 29 3-20 miles rural rds. in Douglas Co., during 1922, recommended to Bd. Co. Commrs. by joint good roads committee. Program proposed includes impvt. of portions of Lincoln Hwy., Center Street Rd., 6th St. Rd., Military Hwy., Briggs Rd. and West O St. Rd.

Nev., Reno—Paving of city streets decided upon by City Council. Will approximate 759,448 sq. ft. Twp. types asph. conc. pavement will be laid. Est. cost $197,056. Harry Chism, City Engr.

N. J., Trenton—Bd. of Freeholders, Mercer Co., plans reconstructing 1.9 mi. White Horse-Yardville Rd., $100,000; 0.2 mi. E. Clinton Ave., $15,000; 0.7 mi. So. Broad St., both sides, $110,000; 1 mi. River Rd., $36,000 and 0.09 mi. River Rd., Washington Crossing, $50,000. H. F. Harris, Engr., Court House. Board also contemplates paving 1½ miles River Rd. at Scudders' Falls (concrete), $80,000.

N. C., Bryson City—Commrs. Forney Twp. plan to grade and surface 25 miles road from here to Tenn. line, $400,000. T. H. Hunter, Chmn. Twp. Comn.

O., Cincinnati—Hamilton County had plans prepared for impvt. of Clough Rd., Batavia pike to $13,500 ft. eastwardly, 8,700 cu. yds. earth embankment, 895 sq. yds. bitum. conc., 24,410 sq. yds., 1-1¼-3 conc. and 26,000 cu. yds. gravel foundation. $129,115. E. A. Gast, Court House, Engr.

O., Elyria—Cleveland-Elyria Rd. will be improved for 12 miles at cost of $160,000.

Okla., Dawson—Tulsa Co. Commrs. will invite bids for constructing road. $250,000 bonds sold.

Okla., Duncan—City will pave approx. 30 additional blocks in resident district. Benham & Mullergren, Kansas City, Mo., Cons. Engrs. Est. cost of work $250,000.

Okla., Oklahoma City—Following work planned for 1922: Chart just completed shows that Cleveland and McClain Cos. have rd. proj. under consideration which has been delayed by litigation, of an est. cost of $200,000; Bryan Co. has proj. est. at $240,094, with Fed. aid of $111,839, which is 20 per cent completed; Ottawa Co. has proj. est. at $345,304, of which $164,155 was Fed. aid funds. It is 89.1 per cent completed. Tulsa Co. has projects est. at $2,170,817, which is 65.8 per cent completed, and it has received Fed. aid of $680,000; Washington County's proj. amounting to $514,769, is 53.6 per cent complete and Fed. aid of $250,000 has been obtained; Okla. Co. projects have totaled $711,423 and Fed. aid of $283,114 obtained. Its project is 93 per cent completed; McCurtain Co. has pending proj. of $790,410 for which it is to receive $362,736. Bryan Co. has done one-tenth of work on its rd. program, est. at $966,184, of which $480,892 was Fed. aid. Work has not started on projects in Okmulgee Co., est. at $944,854, of which $250,000 was to be Fed. aid, or in Muskogee or Haskell Cos., where $622,200 is to be expended with Fed. aid of $278,497, etc.

Okla., Okmulgee—City officials expect to get the 8th St. paving job under way by first of March. Part of the work has started at cost of $55,000. Entire project will cost over $150,000.

Okla., Poteau—Leflore Co. will pave hwy. across entire county. Voted $800,000 bonds.

Ore., Eugene—More than $800,000 in sight at present time for new rd. constr. and impvts. in Lane Co.

Pa., Harrisburg—Agreement on constr. of hwys. of importance to interstate travel, on which U. S. Govt. will furnish financial aid, reached by hwy. engineers of Pennsylvania, New York, New Jersey and the Government. Roads to be built will connect Phila. and Trenton, Easton and Philipsburg, Eastward, Portland, Penn., eastward and eastward from Columbia, N. J.; through Erie Co.; Warren and Jamestown; Bradford, Northward passing, westward to Olean; Mansfield to Elmira, Towando to Waverly, Stroudsburg to Port Jarvis and Scranton to Binghampton.

S. C., Greenwood—City will pave streets at cost

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Fine Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
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Joint Fillers (Paving).
The Barrett Co.
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Kettles (Portable).
Cummer & Son Co., The F. D.
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Littleford Brothers.

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Brown Portable Conveying Machine Co.

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Madison Foundry Co.
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Mastic.
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Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

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Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

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Acme Motor Truck Co.
Duplex Truck Co.
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National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

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The Barrett Co.
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The Texas Company.

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Pioneer Asphalt Co.
The Texas Company.

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W. W. Strickler & Bro.

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The Texas Co.

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De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

of $200,000. Tomlinson Engrg. Co., Engrs., Columbia.

Tex., Dallas—Following decision to sell the $1,250,000 street bonds the City Comn. was preparing to resume impvt. activities. Projects totaling approx. $500,000 in paving, storm sewers and street widening will be launched.

Tex., Palo Pinto—Palo Pinto Co. will constr. 42 miles Hwy. No. 1 through county; cost about $1,400,000. E. L. Pitts, Co. Judge; G. W. Courter, Cons. Engr., Marlin, Tex.

Wash., Seattle—Expendt. of approx. $550,000 for impvt. of county hwys. during 1922 is contemplated, according to announcement made by Co. Engr. Thos. R. Beeman. Principal projects planned are: Completion of paving of hwy. around Lake Washington by paving 3¾ mi. bet. Bellevue and Newport, at $112,500; 5 miles on Sunset Hwy. from Issaquah to Preston, $75,000 from King Co. and like amt. from Fed. Govt.; tearing up 5-mile Kent-Orillia Hwy. and laying of conc., $150,000; grading and graveling mile and a half east valley rd. from Auburn so. to Pierce Co. boundary, $20,000, etc.

Wash., Spokane—U. S. Dept. of Interior is planning constr. of 34 miles new highway, costing $320,000, during 1922 in national parks. G. E. Gooding, Washington, D. C., Chief Engr. of National Parks Service. One of the most important projects will be the constr. of connecting link bet. east and west sides of Glacier National Pk.

Wis., Chippewa Falls—Chippewa Co. Commrs. may purchase patrol graders, scarifiers, plows, tools, etc., for county road work. Special meeting March 15. P. O. Lokrantz, Co. Hwy. Commr.

Wis., Hudson—St. Croix Co. will probably purchase additional truck bank sloping attachment for grader and wheelers and slips. Poe Caffrey, Co. Hwy. Commr.

Wis., Juneau—Will advertise bids for paving abt. 35 miles 18-ft. concrete road and about 20 miles 16-ft. gravel surface. Survey made. Also small bridges. Div. Engr., A. L. Hambrecht, Madison; Hwy. Commr., E. T. Klug, Juneau, $1,100,000.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Los Angeles—Ord. passed by Council and bids will be issued soon for constr. of Arroyo de la Secatella storm sewer, estimated to cost $2,500,000. Contractors will be given about 60 days to figure the work. Dist. embraces about 16 sq. miles in Hollywood and western part of city. Main lines, not including connects. to catch basins, will total about 80,678.71 ft., part of which will be monolithic reinf. conc. and part reinf. conc. pipe. In addn. to constructing drains and catch basins there will be a large amt. of paving, curb and sidewalk work in the nature of repairs.

Cal., Richmond—San Pablo San. Dist. will take bids about March 1, for constr. of 570 lin. ft. 6-in., 1,070 lin. ft. 8-in., 2,200 lin. ft. 10-in., 4,600 lin. ft. 15-in., 1,429 lin. ft. 21-in., and 5,250 lin ft. 24-in. vit. sewers, etc. R. L. Calfe, 221 S. 2nd St., Engr.

Ill., Glen Ellyn—Plans being prepared for 2 miles of 8-10 in. vitr. tile san. sewers in College Hill Addn., $30,000. G. G. Nelson, Sherwin Bldg., Elgin, Engr.

Ky., Paducah—Designs for approx. $600,000 worth of trunk line sewers here are under way; bids to be received, probably, before June 1st. Henry A. Pulliam, Commr., Public Works and City Engr.

Mich., Kalamazoo—Having prelim. plans made for sewer extensions, vitr. crock and brick, or conc., $100,000. E. S. Clark, City Engr.

Mich., River Rouge—It is planned to constr. 2 miles main outlet sewers, 4-6 ft. diam., depth of cut 10 ft., $100,000. G. Jerome, 1331 Majestic Bldg., Detroit, Engr.

Minn., Minneapolis—City Council has approved recommendations by Comm. on Sewers for emergency constr. to cost $337,000. Purchasing Agt. directed to obtain bids for materlal for work. Following projects recommended: Lateral sewer on Universal Ave., 12th to 13th Sts., $2,750; main sewer on 31st Ave., northeast from 5th to Central, $10,000; Main sewer on 42nd Ave., Washburn to Thomas and on Washburn from 38th to 42nd, $66,120; Linden Hills Dist. sewer, $65,520, and Minnehaha Creek sewer tunnel, $75,000.

Neb., Omaha—City will build 4 large sewer projects this year. Includes 800 ft. to Minne Lusa sewer; Saddle Crk. sewer from Poppleton Ave. and 15th Ave. to Center; Spring Lake Park to 13th and J Sts.; W. from Ft. Omaha at 37th and Redmond, 15 miles. C. F. Bossie, City Clerk, $500,000.

N. M., Albuquerque—City Engr. Kimball recommends following impvts.: Sewage disposal plant, $115,000; extens. to san. sewer, $50,000; storm sewer extensions, $95,000; new reservoir with pumps and additional pipe line, $50,000.

N. Y., Rochester—Com. Council passed Ord., providing for $377,000 for new storm water outlet sewer, known as Goodman Street and Webster Ave. outlet sewer.

O., Bexley (Columbus P. O.)—Plans about 2 mi. and 8 and 10-in. sewers, $85,000. Jennings-Lawrence Co., Hartman Bldg., Columbus, probably engrs.

Ore., Pendleton—Engrg. work for city's septic tank will be done by Maar and Cunningham, Cons. Engrs., Portland. Dept. Public Wks. will constr. Lents truck sewer at est. cost of $750,000.

Tex., El Paso—City will extend sewer system; voted $250,000 bonds; also install sewage disposal plant; voted $125,000 bonds. Chas. Davis, Mayor.

Wash., Aberdeen—Constr. of 2 trunk sewers, one in South and the other in West Aberdeen, authorized by City Council.

Wis., Milwaukee—Survey being made for sewers to drain Milwaukee Co. About 22,000 ft., 30 to 48 ins. conc. pipe, 400 ft., 20 ins. cast iron pipe. T. C. Hatton, Engr., City Hall; Metropolitan Sewerage Comn., 221 Grand Ave., making survey, $3,000,000.

WATER SUPPLY AND PURIFICATION.

Cal., Monterey Park—$225,000 bond issue carried for municipal water system. Olmsted & Gillelen, Hollingsworth Bldg., Los Angeles, Cons. Engrs.

Cal., Sacramento—$500,000 bonds voted here by citizens for completion of filtration plant; also $200,000 for waterfront impvts.

Cal., San Diego—Hydr. Engr. H. N. Savage has recommended to Council immediate constr. of dam at Mission Gorge,; est. cost $3,250,000, including filter plant and conduit to city at 11th St. and So. side Balboa Pk. He proposes gravity type masonry dam 116 ft. high impounding 87,000 ac. ft. water. He estimates cost of dam at El Capltan site at $4,500,000. East San Diego—City Engr. E. Paul Ford, has been instructed to prepare plans and ests. of cost for complete municipal water distributing sys. which will require some 30 miles of pipe and a large number of fire hydrants.

Ont., Windsor—Border Cities Utllities Comn., having plans prepared by J. K. Keith, Engr., 1246 Howard Ave., for joint filtr. plant and reservoir to supply Windsor, Walkerville, Ford, Sandwich and Ojibway. $1,000,000.

Conn., Kensington—Fire Dept., making plans for extension of water supply system, $100,000. L. A. Oldershow, 150 Main St., New Britain, Engr. D. F. Crowley, 255 Main St., Bristol, Assoc. Engr.

Ia., Muscatine—City will make impvts. at water works plant tbis summer which will cost about $50,000. Wk. Includes laying 16 or 20-in. main from pump plant on Island to Grandview Ave., and new pumps. Wm. Molis, Supt., Water Dept.

Minn., Minneapolis—City plans 2 miles 24-in. mains from Mt. Curve and Humboldt Aves. to Lake Calhoun and Linden Hills Dist., at cost of $128,000; brick water tower in northeast section, at $37,000. W. N. Elsberg, Engr. Work will be done by day labor.

N. J., Camden—Impvts. in facilities of N. J. Water Service Co., serving Camden Co., ordered by Public Utility Comn., calling for new standpipe, mains in all streets of Audubon, Oaklyn and Barrington, also completion of distribution system in Barrington.

O., Newark—Plans being made and bids will be asked about April 1st for filtr. and softening plant, 6,000,000-gal. daily capy., $225,000. C. P. Hoover, 186 W. Spring St., Columbus, Engr.

Tex., Paris—City will expend $1,000,000 to install water works; plans constructing 3,000,000-gal. capy. purification and pumping plant, including earth and conc. dam; 4½-mile, 18 or 20-ft. cast iron pipe line; 4,000,000-gal. capy. elevated steel tank. Jno. B. Hawley, Cons. Engr., Calton Exchange Bldg., Ft. Worth, Tex. Plans extending cast iron pipe distribution system.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Co., Ltd., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.
Littleford Brothers.

Tar and Pitch.
The Barrett Co.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
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Trench Machinery.
Austin Machinery Corporation.
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Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warranite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
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The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Mueller Mfg. Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
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Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
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Murphysboro Paving Brick Co.
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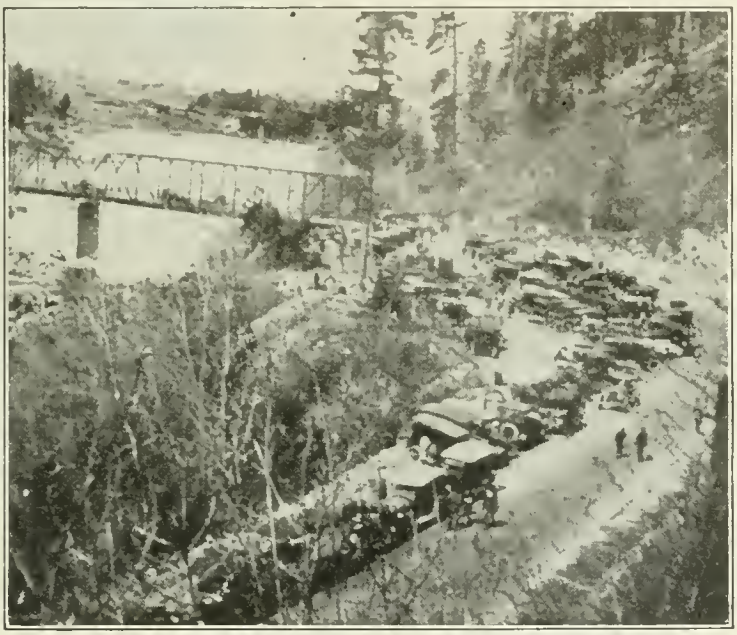

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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE
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KENTUCKY ROCK
Kyrock
ASPHALT

Solving the Problem of Street

Kentucky Rock Asphalt has solved the problem of street maintenance in cities where equipment for mixing the hot mixed types of asphalt is not available. Even in the larger cities, this natural asphalt mix is being used for patching and resurfacing, because of the inexpensive method of handling and laying and the fact that Kentucky Rock Asphalt always gives uniformly successful results.

Kentucky Rock Asphalt is a natural asphalt mix which is shipped ready to lay cold on any base sufficient to carry the traffic. The finished surface is smooth and resilient, having the same appearance as sheet asphalt. In many ways, however, Kentucky Rock Asphalt is superior to the hot mixed types. It does not crack, roll, buckle or bleed. It will not lose its life and ravel at the edges even after years of traffic.

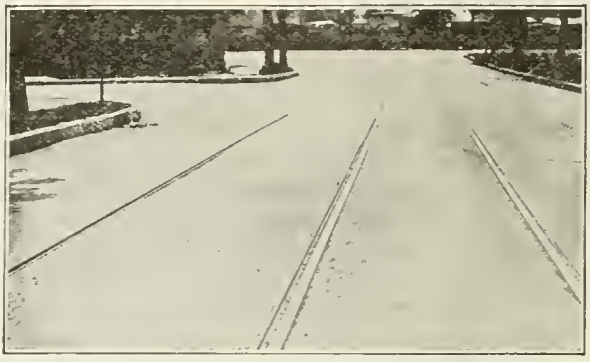
* * * *

Methods of handling and the ease of laying Kentucky Rock Asphalt mean a decided saving in street maintenance costs. The material is shipped in open top cars and may be stored in the open, without harm from the elements. Recently, one of our engineers found some rock asphalt in a ditch along the Nelson Avenue road at Columbus, Ohio. The material had been subjected to the action of the weather and decaying vegetation since the road was constructed in 1909, yet it was as live as the asphalt shipped from our plant today and a portion of it was used in patching the pavement.

* * * *

Kentucky Rock Asphalt is being used for patching and resurfacing old brick, asphalt, concrete and macadam streets.

In patching asphalt, the old surface is cut away, leaving the edges perpendicular. A light coat of asphalt paint is then applied to the edges. The Kentucky Rock Asphalt is spread cold. Small patches may be be satisfactorily compacted with a hand tamp and after a few days traffic, can not be distin guished from the old asphalt surface. Old brick surfaces may be patched just as readily. Where repairs to the foundation are not needed, the Kentucky Rock Asphalt may be used to fill the depression, and feathered out at the edges of the patch. The illustration here shows such a patch.



Shipp Ave., Louisville—Old sheet asphalt patched with Kentucky Rock Asphalt

* * *

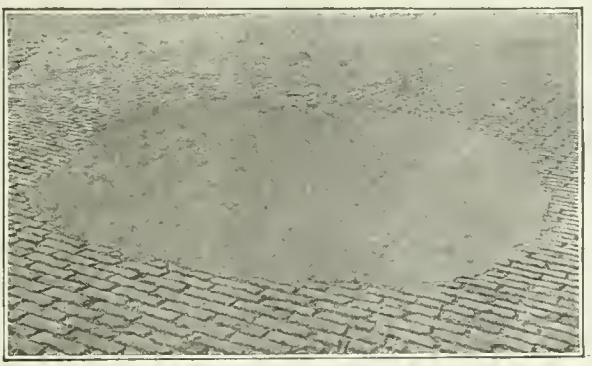
By using Kentucky Rock Asphalt, one man with a light truck, a tamp and a shovel, can easily maintain thousands of square yards of pavement. Repairs may be made as soon as defects occur, thus preventing extensive damage to surface and foundation.

KENTUCKY ROCK Kyrock ASPHALT

Patching and Re-Surfacing

Many streets, in such bad repair that they appear impossible to restore without complete reconstruction, can be saved with Kentucky Rock Asphalt. Properly handled, the old street makes an excellent base for a Kentucky Rock Asphalt surface, and a great saving is effected. In fact, such construction is often most successful in that traffic has developed the weak spots in the old base. They are easily detected and can be repaired before applying the new surface. The finished Kentucky Rock Asphalt surface gives a sheet asphalt street.

Nothing has proven as satisfactory as Kentucky Rock Asphalt for surfacing old brick streets. The material bonds tightly to the brick and will not slip, scale or buckle under the heaviest traffic.



Old brick surface at Louisville patched with Kentucky Rock Asphalt

Resurfacing brick with Kentucky Rock Asphalt is both simple and inexpensive when compared with the cost of applying the hot mixed types of asphalt. First the old surface is rolled to develop the weak spots. All depressions are filled to the proper grade. After the surface has been thoroughly cleaned, the Kentucky Rock Asphalt is spread COLD and when rolled, gives a perfect sheet asphalt surface which may be thrown open to traffic immediately.

Much the same process is used in resurfacing old block and cement concrete pavements. In resurfacing macadam streets, it is often advisable to build up the base by adding crushed stone or slag before applying the Kentucky Rock Asphalt surface.

* * * *

Kentucky Rock Asphalt is a perfect asphalt mix. The mineral aggregate is pure silica sand so hard it cuts like a diamond. The material does not lose its life. Cut the surface today and tomorrow it will be healed by traffic.

Asphalt has made it possible to make permanent street repairs and to resurface worn-out pavements without special mixing or heating equipment or high-priced skilled workmen. Kentucky Rock Asphalt is used in thirteen states for maintenance, resurfacing, and new construction on both streets and highways. It is recognized by the U. S. Bureau of Roads as one of the highest types of surface.

* * * *

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> "At the present time we have *one mile* of the **Heltzel Heavy Duty Road Forms** which *we have used for the past two seasons,* and which have *given us complete satisfaction.*"

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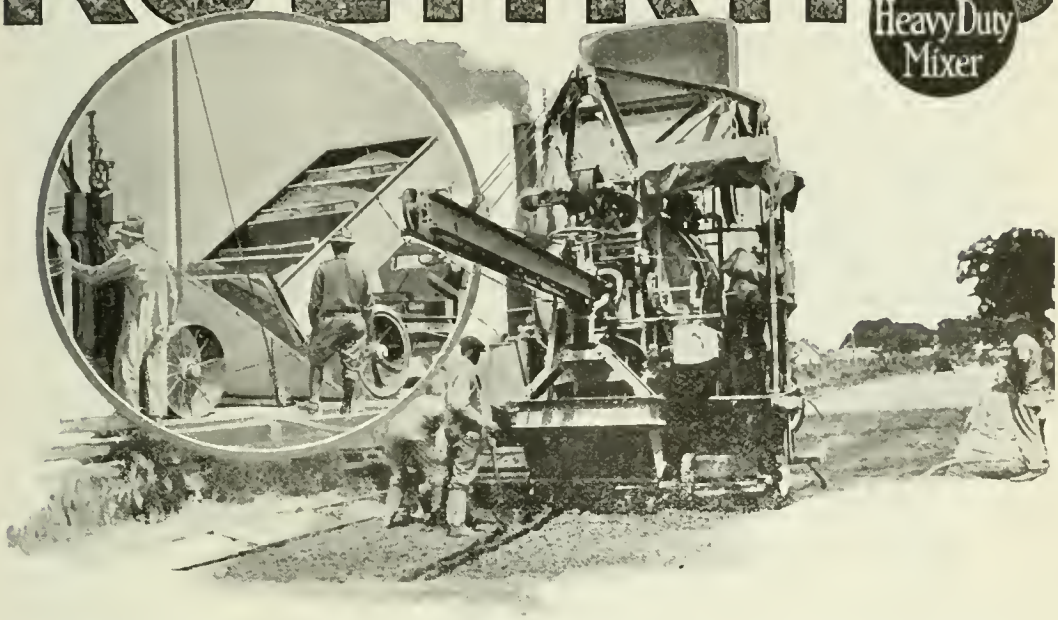
KOEHRING

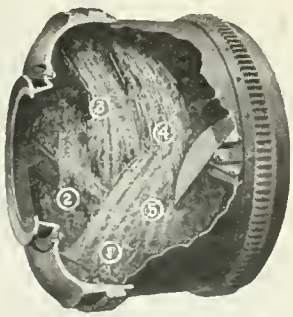
The Heavy Duty Mixer



Dominant Strength Concrete

KOEHRING remixed concrete is *dominant* strength concrete, stronger than concrete mixed by mixers of ordinary mixing action, from the same aggregate, under standardized competitive test conditions. In some instances Koehring-mixed concrete has been as much as 31% stronger by cube compression test.

This is the result of the Koehring *re-mixing* action which returns materials from the discharging side to the charging side for repeated trips through the mixing action—also because the Koehring discharge chute, reversed in mixing position, sprays the aggregate poured on it by the pick-up buckets, and prevents separation of aggregate according to size. To the last handful of every batch, Koehring mixed concrete is uniform Dominant strength concrete.



(1) Long diagonal blades throw and knead materials. (2) Materials carried up with the drum spill back against motion of the drum. (3) At a higher point, materials are hurled from the diagonal blades across the drum, toward discharging side. (4) Picked up by the buckets, materials are cascaded down on reversed discharge chute and (5) sprayed back to charging side of the drum.

KOEHRING COMPANY, MILWAUKEE WISCONSIN

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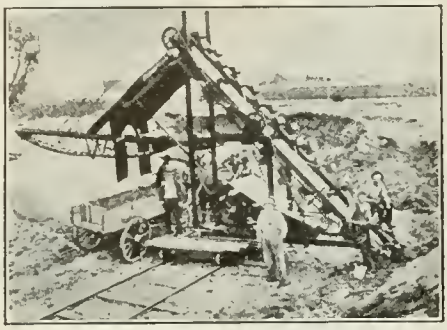
Takes Gravel out of Pit or Pile, Screens out Sand and Stones and Loads the Gravel into Wagons or Trucks.



Several Counties have Purchased Eight or Nine Machines

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The Screener and Loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

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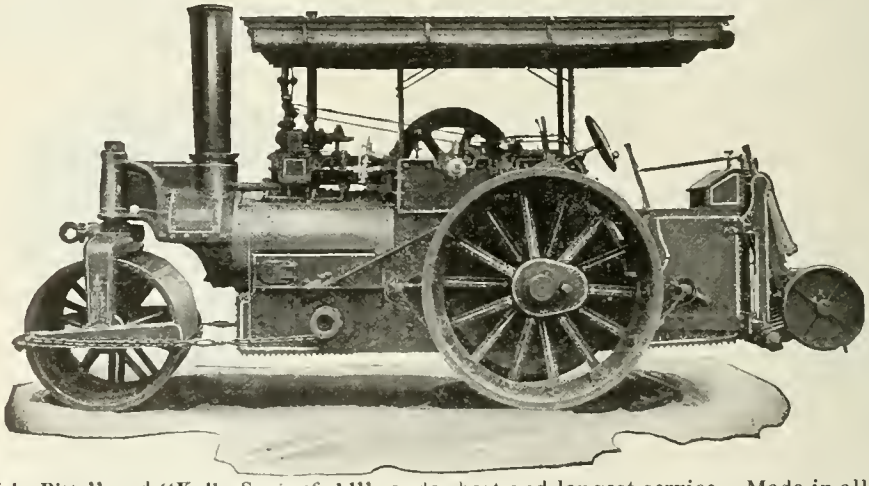

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TEXACO Asphaltic Concrete pavement on Mulvane Avenue, Topeka, Kan. Laid 1909. Photographed 1922.

Strategically located in the heart of our mid-western wealth and resources, the City of Topeka, Kansas, grew as the West grew, prospered as the West prospered, and today is regarded as one of the dominating industrial centers of the region west of the Mississippi.

It houses the extensive shops of the Santa Fe Railroad, it fosters an enormous wholesale and jobber business, and its products of pottery and flour are widely known and used.

TEXACO Asphaltic Concrete pavement on 5th Street, Topeka, Kan. Constructed 1915. Photo Taken 1922.

The family of TEXACO Asphalt streets in Topeka includes one 13-year-old pavement—still sturdy and well preserved—good for years to come.

The TEXACO family in Topeka also includes an 11-year-old pavement, which will render the same excellent service many years more.

And, finally, there are a number of 6-year-old TEXACO Asphalt pavements in Topeka which have withstood—admirably—the tests of weather and traffic.

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Preference Given Asphalt Filler for Brick Pavements

The National Paving Brick Manufacturers Association has officially declared its preference for asphalt-filled brick wearing-surfaces for streets and highways *without prejudice to any other type of filler which may be specially adaptable to local conditions.*

The Resolution is as follows:

Whereas: The National Paving Brick Manufacturers Association through its contact with the requiremements of the paving market, maintained through the members and field engineers of its Territorial Associations, is increasingly conscious of the trend in engineering design and construction toward asphalt filler, and:

Whereas: Recent investigation discloses that approximately sixty percent of all brick pavements laid in 1921 were so filled, and:

Whereas: The Association interprets this increased proportion of asphalt-filled brick pavements as indication that the majority of engineers and public officials, using vitrified brick for paving, believe that the use of such filler, under specifications providing quality and method of using according or equal to those of the National Paving Brick Manufacturers Association, is calculated generally to insure the construction of brick pavements equal in endurance and economy to the endurance and economy inherent to the individual brick as manufactured, and:

Whereas: It is the traditional policy of this Association publicly to declare its judgment, from time to time, in respect to purposes which it regards as encouraging the wisest use of public funds for paving purposes, therefore:

BE IT RESOLVED: That the National Paving Brick Manufacturers Association, assembled in annual conference at Pittsburgh, Pennsylvania, on December 7, 1921, hereby expresses its confidence in asphalt-filled brick wearing-surfaces for street and highway paving properly designed and built with acceptable materials and thorough methods. And that this Association hereby declares its preference for the asphalt-filled types of wearing surface—

PROVIDED: Preferment of the foregoing type of brick wearing-surface for general use shall be without prejudice to any other type which may possess peculiar adaption to special local conditions.

The burned-in service value of vitrified Paving Brick is matched by the aggressive Public Service spirit of the Paving Brick industry.

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804 Engineers Building Cleveland, Ohio

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Indiana Paving Brick Manufacturers Association, Fidelity Trust Bldg., Indianapolis, Ind.
Illinois Paving Brick Manufacturers Association, Chamber of Commerce, Chicago, Ill.
Ohio Paving Brick Manufacturers Association, Hartman Building, Columbus, Ohio
Southern Clay Manufacturing Company, Volunteer Building, Chattanooga, Tenn.

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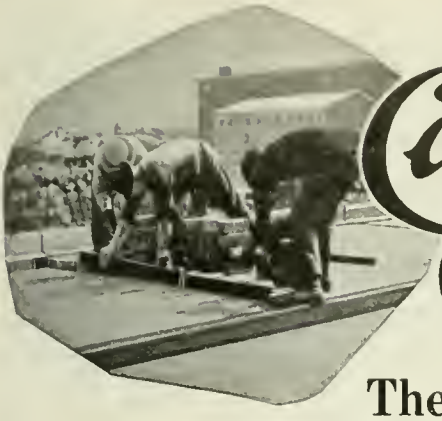

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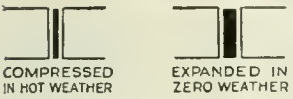

Elastite performance itself is not affected by temperature. By resilient compressibility it takes up expansion and contraction in the concrete. It does not "squeeze out" above the surface, being highly compressible within its own volume. It does not wear down below the surface level.

ELASTITE joints never open. Elastite yields as concrete expands under high temperatures and adheres tightly to both abutting slabs as the concrete contracts in low temperature, maintaining perfect continuous closure by resilient reaction from compression.

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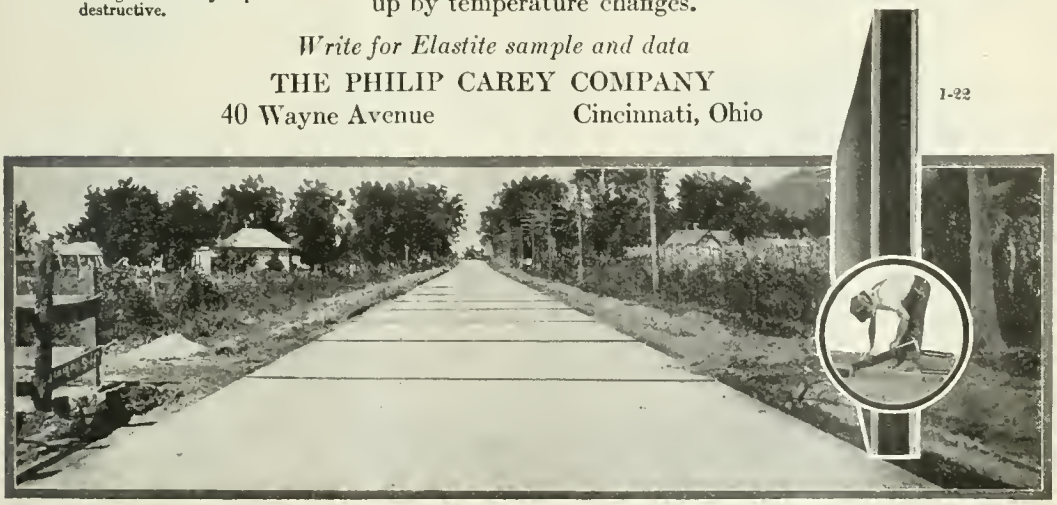
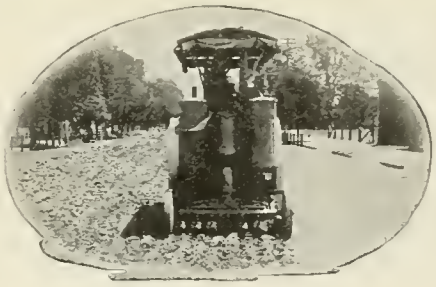


A Prominent Western Highway



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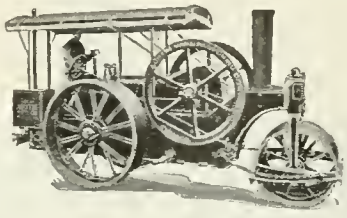

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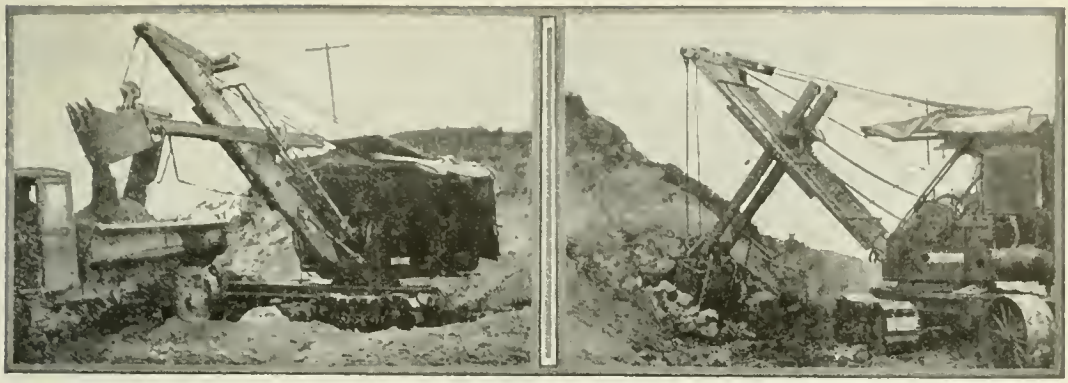

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WHEN the County Engineer of Hennepin County, Minnesota, needed a power shovel for cutting down the corners of a hill at a road crossing, he did not buy a complete new shovel. But *he got a shovel* just the same.

He simply ordered a P & H Shovel Attachment which he used in place of the standard boom of the P & H one-man operated Excavator that he has been using for over a year.

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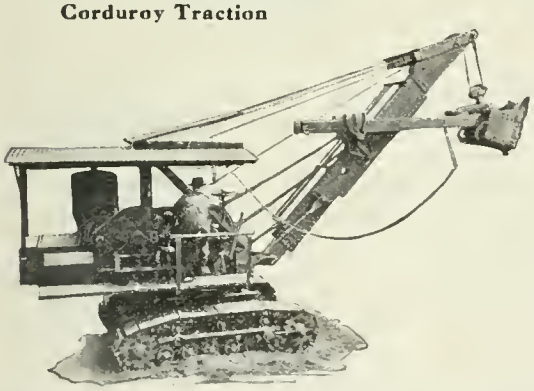

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Use the exact amount of slag, gravel or stone needed on the roadbed, spreading it from the back of the truck to the required width and depth. They do it cheaper and better than men.

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A Burch Spreader will pay for itself in a mile in the saving of wages and material. It will expedite road work, reduce the cost of supervision, and in every way improve the job.

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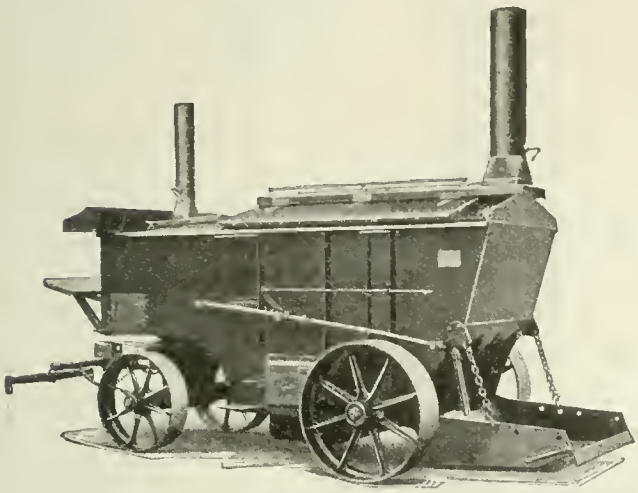

The New Improved Andresen Road Repair Outfit

IF you have roads or streets that you wish to keep constantly in perfect shape, write for the booklet —*"Modern Methods for Maintaining Roads and Streets."*

This Booklet free—
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—Wire Mesh

Motor Truck Operation and Accounting—79

PREJUDICE AGAINST TRUCKS SEEN IN TEXAS LAW

By A. L. Reed, Vice Chairman, Transportation Committee, Dallas Chamber of Commerce, Dallas, Texas.

The last Legislature of the State of Texas has taken a direct slap at motor truck transportation in this State, says Mr. Reed, writing in the Dallas News. It has shown by its act that it was not in sympathy with the development of this new and important step in our transportation system. The act known as H. B. No. 32, or the so-called Truck Law, bears all the marks of prejudice and selfishness.

Which reminds me that all progress in the transportation field has met with serious opposition. The railroads were opposed by prejudice and selfishness. In some States there are, even to this day, statutes prohibiting the construction of railroads because they interfere with religious worship and might set fire to growing crops. The owners of canals vigorously opposed the granting of franchises to railroad corporations, and they were joined by the owners of turnpikes. These selfish interests played on the prejudices of the public and did, in some instances, succeed in arresting temporarily the development of what is now the greatest transportation system in the world, that is, the railroads of the United States. The general public saw the light in the case of the railroads, and if I don't miss my guess, they will see the necessity for motor truck transportation and come to the rescue. Public opinion needs only to be informed to take the right action.

The development of motor truck transportation within the State can be had without undue damage to highways if the proper laws are enacted to protect both the trucks and the highways. Overloading should be prohibited and some reasonable maximum gross weight should be prescribed.

What Texas Has Done

Texas has enacted a law to govern motor trucks that discriminates against its citizens, confiscates their property and imposes unjust taxes; it does more, it arrests community development, drives money from the State, aggravates the unemployment situation, gives notice to the world that our highways are not as good as in other States, and implies, of course, that we don't intend to build good highways. This law imposes a tax on motor vehicles on the basis of ownership without regard to the operation thereof. Business may be such that a man will not need to operate all the vehicles he owns. Such a business condition is being experienced at the present. But in this State we are required to pay an operating license fee, and also State, county and city taxes without regard to whether or not the vehicles are in actual operation and without regard to whether or not they are earning anything for their owners.

Several million dollars in motor truck equipment is rendered worthless by the absolute prohibition of a greater carrying capacity than 8,000 lbs. This provision puts the 5-ton truck operator in this State out of business and makes his property worthless. The law provides for fees on the rated carrying capacity and prohibits the licensing of trucks with a greater rated carrying capacity than 4 tons, except that in special cases, permits will be granted to carry 5 tons on a 5-ton truck over certain designated highways. The man who obtains a permit, of course, is lucky, but the man who doesn't—well, he is just unfortunate. I do not think there will be any permits granted. At a recent conference of truck users and the Commissioners' Court Judge Arch C. Allen made it very plain that his court at least would not grant any permits or approve the granting thereof for the operation of 5-ton trucks with 5-ton loads on the highways of Dallas County. Judge Allen evidenced, however, in this conference, a desire to assist the owners of 5-ton trucks in Dallas as much as possible, and he stated that his court would approve applications for the use of 5-ton trucks where the owner thereof would agree to haul only 4 tons.

Law Unjust

The Highway Commission has referred the owners of these vehicles to the various County Commissioners for approval before they will grant a permit for the operation of a 5-ton truck. Therefore, with the disapproval of the Commissioners' Court, the owner is without a license and subject to arrest and fine of $200 each day and each truck is considered a separate offense. This provision of the law is both unreasonable and unjust. It is

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

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unreasonable because it sets the limit on the rated capacity of the motor truck rather than upon the gross weight of the loaded vehicle. It must be obvious to all men of sound mind and reasoning power that it is the total weight of the truck and its load combined that affects the highway. For instance, the chassis of a 4-ton truck of one make may weigh more than the chassis of a 5-ton truck of another make. The writer has in mind two instances where this is a fact. Again, the user of a 4-ton truck may use a body that will weigh more than the body used on a 5-ton truck. All operators of trucks know this to be the case in many instances. In fine, the truck, body and load of a 4-ton truck loaded with 4 tons may weigh, say, 20,000 lbs. The truck, body and load of a 5-ton truck loaded with 5 tons may not weigh over 20,000 lbs. This is a fact due to the difference in construction of the truck; the size of the body and the material used in the construction of the body. Yet, in one case the law permits the operation over the highways and denies it in the other. This is the law, regardless of the fact that a 5-ton truck of a gross weight of 20,000 lbs., will do less damage to the highways than a 4-ton truck with a gross weight of 20,000 lbs., because the 5-ton truck will in most cases have a greater tire width than the 4-ton truck.

There are many other inequalities in the law, but of minor importance. The greatest objection to the law, as I see it, is it prohibits the use of a vehicle on its rated capacity without regard to the gross weight thereof; the weight of the vehicle and its load combined. The law, therefore, forbids in one case what it permits in another. Passing laws on the manufacturers' rated capacity of a truck is of the same level of common sense as if the merchants of this State granted credit on our own estimation of our credit rating or financial standing.

Texas Needs the Trucks

Texas is one of the States of this Union that was not fully developed before railroad building reached its high mark and then stopped. Most all of the older States of the Union were at their present stage of development when railroad building practically ceased. Therefore, community life has reached a more intensified development in these States than it has in Texas. The railroads developed these older States by providing cheap transportation for short and long hauls. Today, however, we find Texas resources practically untouched, and the railroad rates higher than at any time in our history. Farm products rot in the fields in this State because the freight rates are so high even to near-by Texas destinations. The value of the commodity is exceeded by the transportation charges. Therefore, it doesn't move.

It is claimed by some railroads that they can not handle short-haul traffic and give service without loss of money. This must be so, because of the enormous terminals within the big cities where property has reached prices where it sells by the inch. Box cars empty ordinarily weigh about 30 tons. The average load of less than carload freight for short hauls in the State is less than 5 tons. Therefore, it takes more motive power to pull empty equipment than it does the paying load. We will say, for instance, that it does cost $1 per ton to handle freight by a steam railroad. In the case above cited it would take $30 to handle the box car empty and $5 to handle the paying load. In the case of the 5-ton truck it is a very uncommon thing where the truck and body combined will weigh more than 10,000 lbs. Therefore, the load of 5 tons is equal to the weight of the empty vehicle and affords an enormous saving in power alone on the handling of traffic. The railroad equipment is 6 times heavier than its load, whereas the motor truck equipment and the load are more equally balanced.

It is, therefore, reasonable to assume in order for a rail carrier to make money out of the haul on less than carload traffic the haul must be such as will warrant a rate sufficient to take care of the terminal expense and the line hauls. This truth is further borne out by the fact the lines give better service on long haul traffic than they do on short-haul traffic. Less than carload freight from St. Louis to Dallas, a distance of 767 miles, is now delivered on the third morning after it leaves St. Louis, while at the same time it takes a week and sometimes longer to get a shipment from Mineral Wells to Dallas by railroad, where the distance is only 85 miles. The reason for this is that local freight receives only every other day service; that is, the St. Louis shipment is almost in Dallas before the shipment from Mineral Wells leaves the city. This is so, regardless of the fact that the railroad charges more for its service from Mineral Wells to Dallas than the truck line. For railroad service you must deliver it to them yourself, and when it does finally arrive you are compelled to

When You Buy a Motor Truck

Select it with care for
It makes a difference (*to you*)

what truck you buy. Your truck should be selected to suit the character of work you expect it to perform.

You would not think of buying a pump in the open market without first satisfying yourself that you are selecting the right type and size to handle your pumping job, and you should not buy a motor truck, at random, without giving careful consideration to the size, type and other features it should have to meet satisfactorily the conditions under which you expect to operate it.

There are over 200 makes of trucks on the market. Any truck manufacturer will take your order, of course, but only a small percentage of all truck manufacturers have made a special study of the trucking requirements of cities, counties, road builders and public works contractors.

These special studies have resulted in up to date, competent motor truck engineering which determines the proper size of truck and the proper truck equipment for solving the various hauling problems of cities, counties, contractors and road builders.

This magazine has published a special Motor Truck Section in every issue for over **six years** and has studied carefully the trucking problems of this field and the **trucks that** best solve those problems.

If in the market for trucks let us know your requirements and we shall be pleased to give you the benefit of expert advice.

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go get it, which cost must be added to the railroad rates.

Will Develop Small Communities

The greatest argument for the motor truck is the fact that it will, by reason of the above facts, develop the small communities by giving them good service at cheap rates to all territory within 100-mile radius. It furnishes the farmer a means of marketing his product and the merchant the means of distributing his wares within that radius which cannot be equaled for economy or efficiency.

The greatest economy effected by motor truck transportation is possibly found in the building material movement. A large amount of sand and gravel is used in the construction of highways and buildings. Motor trucks can handle this material from the point of production to the point of consumption often for a cost equal to what it would cost to load the material in a box car or flat car of the railroad company, to say nothing of the fact that there would still be a further cost in the case of the railroad of unloading the cars and delivering the material to the point of consumption. In view of the fact that we are undertaking extensive highway development in this State and, further, the fact that our markets are only slightly developed in comparison to the older States, it would seem that our Legislature would desire beyond all other things to foster the development of this cheap means of transportation.

But legislation should consider all interests. There must be a common ground on which we all can stand; that is, the truck users and the highway engineers. It, of course, is not economy for the State to construct highways and have them torn to pieces in order to give us cheap motor transportation. Neither is it economy to construct expensive highways and not obtain the benefits of cheap transportation that they offer us. The sensible thing to do is to place some limit on the trucks that will allow them to operate and earn money and, at the same time, do the minimum damage to the highways. The gross weight limitations are the best and are, in my judgment, the only effective means of limiting the damage to the highways. In this connection it might be of interest to see what the other States are doing. Four States have a limit of 20,000 lbs., three States 22,000 lbs., three States 24,000 lbs., one State 25,000 lbs., 2 states 26,000 lbs, 3 states 28,000 lbs., and 3 States 30,000 lbs. Therefore, 19 of the States are permitting 5-ton trucks and over to operate. It means to me that Texas should, at least, be willing to take the averages gross weight limitations of the several States and adopt it as a limit. In view of what the other States are doing, it seems that 26,000 lbs. gross weight would be a fair limitation to place upon motor trucks in this State.

The tendency to limit the capacity of trucks to an extremely low minimum is the result of differences of opinion between highway engineers on the one hand and truck users and manufacturers on the other. In this connection the writer was very much impressed by an article in Engineering News Record, Volume 87, No. 9, Sept. 21, 1921. In this article, which is entitled "The Trend of Motor Vehicle Legislation," the data has been gathered by an engineering expert from all States and is presented in a non-technical form. It is an excellent statement of the highway engineers' position as compared to the opinion of the users and manufacturers. Studying of this article by our Legislature should produce satisfactory results for the State and for the users in the State.

The law limiting the use of a vehicle with a greater rated capacity than 8,000 lbs. is now a law in this State and the question is seriously before the owners for action. The Legislature does not meet again until 1923. It seems to me that the State Highway Commission should come to the rescue of the owners and permit the use of the 5-ton vehicles that were already owned in the State prior to the passage of the law now in effect. Refuse to license new vehicles, but uniformly permit the re-licensing of all 5-ton vehicles that were registered during the year 1920. This is the equitable and just thing for the present. Then at the next session of the Legislature it is up to the owners and manufacturers to convince the Legislature that it is in the interest of economy to operate at least a 5-ton vehicle upon the highways of Texas.

TRUCK IN UNUSUAL HAULING FEAT

"While the Dual-Valve engine which is standard in all models of the Pierce-Arrow truck is conceded to be the most powerful truck engine built, few actually realize how tremendous its power is," says R. O. Patten, truck sales manager of the Pierce-Arrow Motor Car Company.

An unusual haulage feat in Omaha, Neb., recently tested the ability of the

Dual-Valve type of truck, says Mr. Patten. J. J. Hanighen frequently calls upon F. L. Busche, haulage contractor of Omaha ,to move an excavating machine which weighs 46 tons. Formerly the combined pull of three heavy-duty trucks was required to tow the ponderous machine. On the most recent occasion, however, Mr. Busche decided to test the power of his new 5-ton Dual-Valve Pierce-Arrow.

Working alone, the Dual-Valve unit towed the 46-ton machine a distance of 5 miles. The truck, with its enormous load, even climbed the 7% grade at 30th and Harney streets without assistance. In the middle of the ascent the truck and its tow were stopped for the purpose of taking photographs. In starting again the excess power of the Dual-Valve engine slipped the driving wheels a half-turn on the dry asphalt before they gained sufficient traction to overcome the inertia of the dead load.

FEDERAL GOVERNMENT SEEKS TO SOLVE HEAVY MOTOR TRUCK PROBLEM

The proper regulation of unusually large motor trucks because of their wear and tear to the Nation's highways, or of restricting their use to certain roads designed to accommodate them, is suggested for consideration in the annual report of the Bureau of Public Roads, United States Department of Agriculture. The bureau, under whose supervision Federal-aid funds totaling $200,000,000, have been expended on highways costing $467,000,000 during the past 5 fiscal years, asserts that the problem of the heavy motor truck is one of prime importance, pressing each year with more weight for solution, which, while not to be hastily solved, ultimately must be met squarely.

"The reduced unit cost of operation which follows from the transportation of commodities in greater bulk tends to promote the development and use of vehicles of the largest capacity which can be used in advantage," the bureau says. "It is desirable to gain this advantage, if it is actually an advantage, but it is this point which is seriously in doubt. The doubt arises from the fact that the roads which are adequate for traffic of automobiles and light trucks are entirely unable to support the weight of the heavier trucks, and to build roads which will carry the heavy vehicles will greatly increase the costs of construction.

"Whether the operation of the heavier vehicles shall be restricted to a class of roads especially designed to accommodate them, or whether all roads shall be strengthened to provide for unrestricted use, or whether the third alternative shall be adopted and the operation of the heavier trucks prohibited, will depend upon the relation which is found to exist between reduced operating cost and increased cost of construction.

"The situation presents an economic problem of the first importance which is not to be hastily solved, but which must nevertheless be met. To do so demands a careful weighing of the effects of the several possible solutions with a view to the selection of that one which, in the long run, will serve best to accomplish the one desirable end—the improvement of our means of transportation.

Experience in One State

"The prime importance of an accurate knowledge of the weights of the vehicles which are to use the roads constructed is well illustrated by the experience of one of the States in which the Bureau of Public Roads made an extensive investigation during the past year.

"Ten years ago this State set out upon the construction of a system of roads. The roads were designed and built to meet all the reasonable demands of the traffic which then could be foreseen. In the brief time which has elapsed roads have been constructed which penetrate to all parts of the State, some of which, however, have been seriously damaged by heavy motor vehicles, the use of which could not have been foreseen when the roads were constructed.

"Our investigation reveals that in this case the return from the roads in the reduction in the cost of transportation and in the development of the territory they traverse has undoubtedly compensated the loss resulting from their destruction; but it is not by any means certain that the outcome will be so fortunate under other conditions.

"For the security of the enormous investment which is being made by the States and Federal Government it is imperative that this question of the duty which the roads will be called upon to render in the future shall be definitely determined. A clearer conception of the relative economy of heavy and light vehicles can be gained by careful study."

The bureau at the present time is engaged in conducting investigations designed to determine accurately the load-carrying capabilities of various kinds of

roads, of various thicknesses upon different kinds of subsoils—a study which will yield valuable information in meeting the problem outlined above. These experiments are being conducted in various sections of the country, in co-operation with State and highway departments, and at the bureau's experiment stations. Another problem presenting itself for solution and under investigation is the variance of the classes of traffic to be served in different localities. Pointing out that the demand for good roads comes from all classes of highway users, the bureau asserts:

The Universal Demand for Good Roads

"The demand of the farmer is for roads from the shipping points and agricultural centers to the surrounding producing areas—farm-to-market roads. The manufacturer and city merchant ask principally for roads which will facilitate the transportation of raw materials and manufactured commodities which flow to and from the cities. The tourist and that large section of our urban population whose direct interest in the rural roads is due to the opportunities for pleasurable recreation which .they afford, are particularly concerned in the development of a system of smooth, hard-surfaced roads connecting the cities and points of national interest. Thus, from the several classes the demand is for roads to meet their particular requirements, while all unite in an appreciation of the need for development of a system of roads which shall serve as a complete supplement to the railroads in the event of war.

"All these are proper demands, which must be accommodated as rapidly as the resources and means of construction will permit. Fortunately the more important requirements of each group may be met by the improvement of a relatively small part of our mileage of public roads."

Approved projects for Federal aid in road-building, up to the end of the past fiscal year, the bureau states, cover 35,402 miles for the 5-year period ending June 30 last, and involve the expenditure of $587,000,000, of which nearly $248,000,000 represents the Federal Government's contribution. The total mileage of completed Federal aid projects during the past fiscal year was 3,809, and the average cost per mile $13,035.

AMERICAN ENTERPRISE IN BRAZIL

Hundreds of tons of Austin machinery will shortly begin to move through New Orleans to Brazil, where it will be employed in driving a tunnel and erecting a municipal market for the City of Sao Paolo. Mr. Robert Morris, head of the Austin Machinery Corporation of Louisiana, has been in Brazil for several weeks working on this deal, which he recently succeeded in closing at a price of $4,000,000. As this is merely the first in a series of municipal improvements to be undertaken, involving the outlay of several more million dollars, Mr. Morris is camping on the ground in the hope of landing other contracts, and thus creating new openings for Austin equipment. If he is successful, the company will probably establish a branch in Brazil, either at Sao Paolo or at Rio.

The story of how the Austin company happened to connect up with this proposition is an interesting one. Some months ago, Admiral Cordeira da Graca, representing the Brazilian Government, was in New Orleans in connection with matters affecting the Lloyd Braziliero Steamship Line. The Admiral was known to be an enthusiast on good roads, so his business friends introduced him to Mr. Morris, who took pleasure in showing him motion pictures of road building that featured Austin equipment all the way from the preparation of the grade to the finished surface. The Admiral had made it clear that he was not proposing to buy anything, so it was with no thought of selling, but merely the readiness of one good roads booster to give all the information he could to a fellow enthusiast, that Mr. Morris discussed at length with the Admiral the best and most economical methods to be followed.

Shortly after the Admiral's return to Brazil a comprehensive State plan of public improvements, that had frequently been talked about but never aggressively pushed, began to take definite shape. With a vivid recollection of the favorable impressions he had formed of Mr. Morris and the Austin line, the Admiral promptly notified him of the opportunity. Mr. Morris boarded the first steamer for Rio where, upon convincing the authorities that he knew how, and could deliver the goods, he managed to secure the first of the contracts to be let.

The Austin company has alrealy done considerable business in Mexico. With Brazil now lined up on a big program of construction, the company proposes to cultivate the entire Latin-American field, believing that it will afford a market of steadily increasing importance.

EDITORIALS

SACRIFICING OLD ROAD METAL FOR NEW LINE AND GRADE

In many places, where local deposits of roadmaking materials were long ago opened up and used in building gravel and macadam roads, there are today very important systems of obsolescent roads. In many of these old roads the metal ranges in thickness from 6 to 18 inches. This depth of metal represents the accumulation of loose material spread over the surface from year to year and consolidated by traffic. We believe that the great majority of road-builders are agreed that these old roads are much too valuable to be scrapped. The approved practice is to utilize them, so far as is possible, as bases for roads of a higher type. Many county, state and city engineers, of wide experience and excellent professional standing, resurface these old roads with bituminous wearing surface and so secure good, modern roads at moderate expense. These resurfaced roads are not new; they are just about as well tried and proven as any class of road construction. It is precisely for this reason that when an engineer discards these old roads as of no further use we think he is running counter to the experience of road builders in this and other countries.

Since these old roads were built up from year to year in piecemeal fashion, often by local highway commissioners without engineering assistance, it is perfectly natural that they should be somewhat deficient as to line and grade when judged by modern standards for new construction. The object of the present discussion is to urge engineers not to discard this old metal because of small faults in line and grade. This is a practical matter and more weight should be assigned to the money value of the old road metal in place than to the artistic value of lines and grades that look pretty on paper to the eye of the trained engineer.

With roads generally following the section lines it is difficult to see how the question of alignment could very often be raised as a reason for scrapping old road metal. Unless the entire right-of-way is to be changed there would seem to be no insurmountable difficulty in making the line of the new road substantially coincide with that of the old one. The question of grade is not so easily handled. Too many changes in grade are undesirable if they come so close together as to make the road surface appear choppy to moderately fast traffic, but it is easy for the engineer to be more critical on this point than the public is. Many motorists express a preference for a surface that has easy undulations as compared with one of monotonous regularity. In general, we believe that the engineer must shoulder the full burden of proof when he says that these old roads must be entirely rebuilt because of moderate faults in grade and alignment. The road-building mood may not last forever; while it does last let us get as many miles of good roads as possible, saving what we can by resurfacing and adding the money so saved to funds for use on entirely new construction.

THE UNRECORDED PROFESSIONAL ADDRESS

During the recent winter season there was the usual number of engineering society conventions, road schools and other conferences of engineers. The programs of these conferences contained an exceptionally large proportion of papers on distinctly practical subjects. It is our practice to request copies of nearly all papers presented before these conventions; only a few of them can be published in this magazine but all are desired as information on the status and trend of affairs in the field. Much more frequently than usual, during the convention season now drawing to a close, we have received letters from convention speakers saying they did not present set papers but spoke extemporaneously from notes and their remarks were not taken down. Thus there is no record of what they said and, save for the imperfect recollection retained by their auditors, whatever of

value was contained in their addresses is lost to the profession. This applies particularly to the road schools.

The unrecorded address represents wasted effort to a considerable degree. Even the man who hears it presented would like to read it carefully at his leisure if it contained matter of interest to him. In general, any address worth listening to is worth reading. If an address was of interest to the small gathering of men before which it was presented, it would be equally interesting to a much greater number of men who did not hear it presented but who would be glad to read it.

The reading of a long and carefully prepared paper sometimes bores an audience, it may be admitted. For this reason many who have prepared papers do not read them in full but present concise summaries of their major features in such a manner as to hold the interest of the audience; in such cases the paper in full is available for subsequent use. This practice is commendable as it appeals strongly to all interested persons, whether they are present or not.

Highway engineers are now living and working under high pressure. Some of them are called upon to make a speech about once a week during the winter season. They say if they took time to write out their addresses and to give them the polish a prepared paper deserves they would not have any time left for their official duties. That there is much truth in this no one will deny, although some of the engineers do manage, in some way, to get nearly all of their addresses reduced to writing.

However, if it is a physical impossibility for some of the highway engineers to get their addresses down on paper we hope this fact will be recognized and that those who conduct the road schools, and other conferences, will arrange to have the addresses taken down while they are being presented. Copies can then be made available to the various journals interested in road work and undoubtedly many of the addresses will find their way into print and become useful to large numbers of people. This is a matter of prime importance in connection with the great highway program now under way.

It has often happened in the past that engineering information has not been given out until after it had gone stale. Right now is the time to publish the best thought of the highway builder—not some years hence when a construction lull comes on. We hope that careful consideration will be given this matter by all interested parties. We make the suggestion in the public interest and not to increase our available supply of "copy," for we already have more material for use than we can publish and the same is true of all other engineering journals.

THE TAX DOLLAR

To the taxpayer the tax dollar is the biggest dollar in the world. The mere mention of taxes is enough to change a spendthrift into a miser. Direct taxation is especially obnoxious to the average man. It is difficult to arouse his interest in the indirect taxes he pays even if these greatly exceed his direct taxes. Perhaps it is not overstating matters very much to say that all sorts and conditions of people, in all times and places, have been in at least mental, and often physical, rebellion against taxation. The politician understands this feeling very thoroughly and dwells upon the subject of "high taxes" in playing upon the provincialism, the passions and the prejudices of the people. The promise to reduce taxes is the greatest vote-getting device ever manufactured and it works as smoothly today as it did two thousand years ago.

In late years some public officials have attempted to show the public, by means of diagrams, what becomes of the tax dollar. This practice is right in principle and is an aid towards a rational consideration of the subject of taxation in any community. It has demonstrated the possibility of getting the public to think of taxes as they do of money spent for other purposes, that is, in terms of what they get for their money. Such rational consideration will eventually lead to better government for when people, generally, become more interested in what they get for their tax dollars than they are in the amount of taxes they pay, they will begin to take such an intelligent interest in public expenditures of all sorts that better government will surely result.

CONSTRUCTING 17¼ MILES OF BRICK PAVED ROADS IN SCOTT COUNTY, IOWA

By H. K. Davis, Chief Inspector, Iowa Highway Commission, Ames, Iowa.

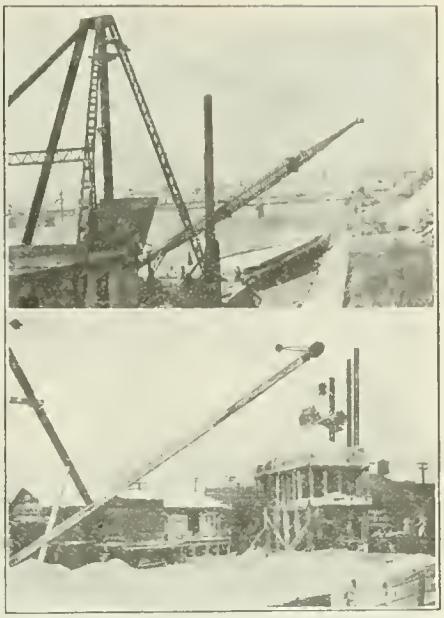
Twenty-three and one-half miles of vitrified brick highway—the 3-in. brick laid flat and filled with asphalt, with a concrete base either 5 or 6 ins. in depth, is the beginning Scott County, Iowa, has made in its highway improvement program. Work on 6¼ miles of the total will be completed this summer, the other 17¼ miles being completed last fall.

Roads Radiate From Davenport

Davenport, a town of nearly 60,000, is the county seat of Scott County. It is located on the Mississippi River, 183 miles southwest of Chicago and is one of the leading commercial cities of the state, having extensive grain shipments and numerous industries. The new brick highways radiate from this center.

The Davenport-Princeton road, 5½ miles long; Davenport-New Liberty road, 6½ miles long, and one section of the Davenport-Gambril road, 5¼ miles long, were completed last fall. The Davenport-Gambril road from Davenport to the Le Clair-Big Rock road, a distance of 6¼ miles, will be completed this summer.

As would be expected, with the type of pavement used, these roads are the principal thoroughfares leading out of Davenport. The Davenport-Princeton road is likely to be, at a not far distant date, a famous show road and a part of the greatest scenic route Iowa will ever have. It lies along the Mississippi River much of the distance between Davenport and Clinton. For many miles the traveler skims along with the Father of Waters always in sight and part of the time on the very banks of the river.



FIGS. 2 AND 3—MATERIAL HANDLING EQUIPMENT USED ON SCOTT COUNTY, IOWA, BRICK ROAD CONSTRUCTION.

Fig. 2—View of Barge Carrying Stiff-leg Derrick Using Clamshell Bucket for Unloading Sand and Gravel Into Stock Piles. This Was the Only Iowa Job on Which Boats and Barges Were Used in Handling Road Building Materials. The Central Engineering Co. Secured Sand from Bed of Mississippi River and Barged it to Central Proportioning Plant on Davenport River Front.

Fig. 3—Stock Pile and Central Proportioning Plant of Central Engineering Co. on Davenport River Front.

Straight north from Davenport is an-

FIG. 1—BRICK PAVEMENT ON DAVENPORT-PRINCETON (IOWA) ROAD FOLLOWING THE MISSISSIPPI RIVER BETWEEN DAVENPORT AND CLINTON. SCOTT COUNTY (IOWA) HAS 23½ MILES OF THESE PAVEMENTS, BUILT AND BUILDING.

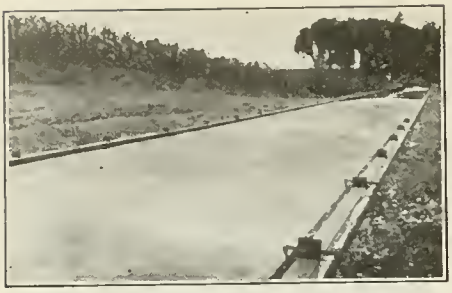


FIG. 4—CONSTRUCTION OF INTEGRAL CURB ON CONCRETE BASE OF SCOTT COUNTY, IOWA, BRICK ROADS.

View Shows Side Forms in Place. Base Laid Without Expansion Joints but Curb Has Joints 10 ft. Apart.

other brick road on what, since the day of the Prairie Schooner, has been known as the Davenport-Dubuque road. On the west and leading northwest from Davenport to New Liberty, is the third of these highways.

The Central Engineering Co. and the McCarthy Improvement Co., both Davenport contracting firms, had charge of the work completed last fall. The Central Engineering Co. constructed the Davenport-Princeton and Davenport-New Liberty roads and the McCarthy Improvement Co. handled the first section of the Davenport-Gambril road. The McCarthy Improvement Co. also has the contract for that section of the Davenport-Gambril road which will be completed early this summer.

Construction Features

Specifications for all jobs provided for concrete curb integral with the base for retaining the brick. Both companies at first began finishing their concrete base by hand, but later mechanical finishing machines were substituted. The curb made it necessary to rebuild the machines, so that both the strike board and the tamper could be lowered several inches below the top of the forms to finish the surface of the base.

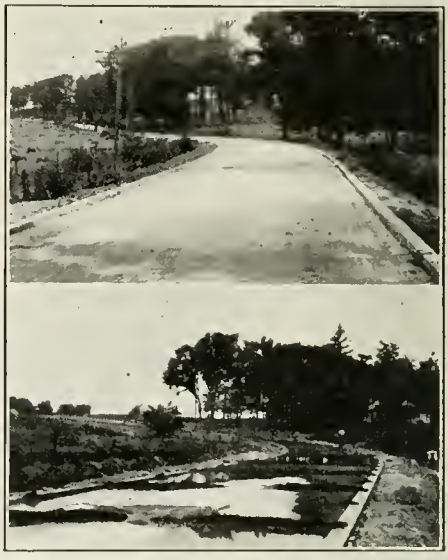
Transportation was one of the features which presented special problems. The hauling distance was considerably more than the average on practically all materials. Sources of supply being so far removed, the rehandling of much of the material was necessary.

The Central Engineering Co. at one time used barges to haul crushed stone from a point down the Mississippi river to a central mixing plant on the levee in Davenport. A derrick mounted on a barge unloaded the materials from the boats into the stock piles on the river bank. A stiff-leg derrick in turn carried the material from the stock piles to elevated storage bins from which the mixer was fed by gravity. A large fleet of trucks hauled the wet mix to the actual point of placing.

Equipment Used

The equipment of the Central Engineering Co. comprised: One mixer of 1 cu. yd. capacity; 1 unloading crane; 12 dump trucks; 1 turntable; 1 finishing machine; 1200 ft. of steel forms; 2 miles of 2-in. pipe line; one 5-ton tandem roller for rolling brick; 1 kerosene engine and pump; one 25-h. p. steam traction engine; one 10-ton roller equipped with steam pressure scarifier; 1 leaning wheel grader with scarifier attached; 2 melting kettles; dump wagons, slips, wheelers, small tools and camp equipment.

The equipment on the McCarthy job consisted of: One stiff-leg derrick, with clamshell for unloading cars and placing materials in bins; 1 central mixing plant containing 28-ft. batch mixer; 25 dump trucks for hauling wet batches; 1 subgrader, 2 steam rollers, 1 finishing machine, 1 small gas tractor, and one grader used especially for maintaining earth roads leading to the job.



FIGS. 5 AND 6—CONCRETE BASE ON BRICK ROADS IN SCOTT COUNTY, IOWA.

Fig. 5—Several Sections of Concrete Base Were Used, During Winter of 1920-21, by Traffic. This Section, Built by the McCarthy Improvement Co., Was Not Injured by Use in Winter.

Fig. 6—Integral Curbs Facilitated the Curing of Concrete Base by Ponding as They Made Side Dams Unnecessary.

Straight Wire-Cut Brick With Asphalt Filler

Plain wire-cut brick were used throughout. Many samples of the brick were removed after the asphalt filler was poured and in every case excellent penetration had been obtained, the ends and abutting surfaces of the brick being entirely and thoroughly coated and the joints completely filled.

Water for the Davenport-Gambril road was obtained from a stream at the extreme north end of the project and carried by means of a series of pumping stations through the entire 5¼-mile length of the project. Water on the Davenport-New Liberty road was pumped from a deep well near the center of the project and carried through a 2-in. pipe to either end of the job.

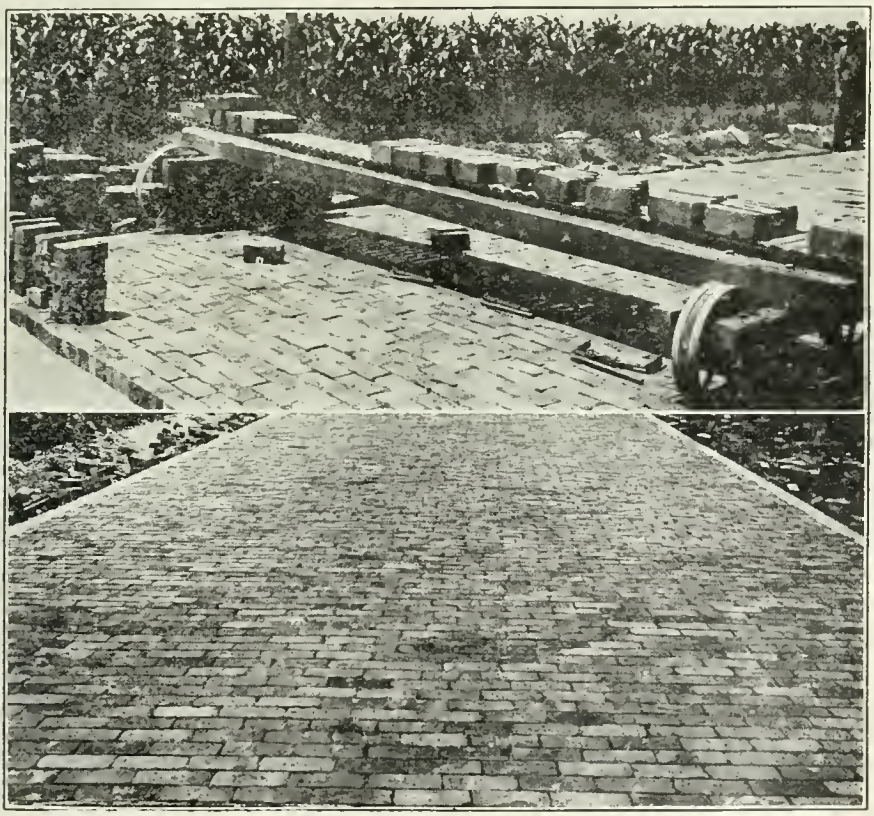
The pouring of the filler was of a generous character. A thin coating of the bituminous material entirely covers the brick surface. Part of this coating will be worked into the joints by the traffic and the balance will wear off in time, leaving the smooth, red brick surface.

DISCUSSION OF A DRAINAGE EXPERT'S IDEAS ON HIGHWAY CONSTRUCTION

To the Editor:

In the January, 1922, issue of Municipal and County Engineering I notice an article by Edgar A. Rossiter entitled, "A Drainage Expert's Idea on Highway Construction."

I think in the past there has been too much emphasis laid on drainage especially as the roads which have been well drained are in no better shape than those without any drain tile. Thousands of



FIGS. 7 AND 8—HANDLING BRICK ON SCOTT COUNTY, IOWA, ROAD CONSTRUCTION.

Fig. 7—Gravity Brick Conveyor Used to Move Brick from Stock Piles to Setters. This Piece of Equipment Performed the Work of 6 to 8 Brick Carriers and by Keeping Them Off the New Surface Facilitated the Application of the Asphalt Filler.

Fig. 8—View of Lugless Brick on Scott County, Iowa, Road Before Filling Joints. A Thin, Uniform Spacing Was Secured by Means of a Straightened Hoe Blade Inserted Between Brick Placed too Close Together.

dollars have been spent on useless drains under the roads and I venture to say that if they were ever tested five years after installation that no water would be found running in any of them. Of course I do not include the piping off of springs or running water or anything like that. This article is aimed at the practice of installing drains where there is no sign of any water.

In this latitude, foundations of buildings are extended in the ground to a depth of 4 ft. to get away from the heaving action of frost. Then how can a road which is exposed as it is, ever be kept free from frost action by drains? If this method were successful why don't architects use it for buildings?

At the road show held in Chicago in January, 1922, the U. S. Bureau of Public Roads had an exhibit which showed drawings of roads which the government had experimented with, some with all kinds of schemes of drains, some with vertical concrete walls at each side of the road extending below frost and some in which the subgrade had been plowed and harrowed and from 1.7 to 4 gal. of water gas tar applied per square yard on different kinds of soil. It was found that about 2 gals. of tar per square yard gave good results in most soils.

It stands to reason that waterproofing the subgrade in this manner will prevent water from getting up under the slab. The deeper the tar is applied the better.

But no amount of drains will remove the water in the soil which is there due to capillarity. Let anyone try the experiment of placing a tube filled with earth with a screen at the lower end in a jar of water so that only the lower end is in the water. The soil in the top of the tube will be wet before long but you cannot pipe this water off if you would insert tubes extending out from the tube containing the soil.

After the government experiments have exploded the old idea of drainage I hope I will never pick up another article on pavements in which one starts to read expecting to find something new and then find that all but the last paragraph tells about how essential it is to place plenty of drains and then more drains and so on.

Very truly yours,

M. J. DOUTHITT, City Engineer.

Waukegan, Ill., Feb. 10, 1922.

(Mr. Douthitt's letter was brought to the attention of Mr. Rossiter, who has written the following reply.—Editor.)

To the Editor:

Relative to the foregoing letter on Roadway Drainage, by Mr. M. J. Douthitt, City Engineer of Waukegan, Ill.:

Mr. Douthitt is in the same position as a farmer on one of my drainage districts who had prevented the work going through for some 10 years. This farmer could never see anything in drainage, cursed everybody that even talked drainage, and when at last we put the work in, lowering his watertable 7 ft., he still claimed it was useless. Two years after I met him and he hailed me thus, "Say, since you put in those tiles I have made more profit in one year than I did in 20 years before and we work just half as long each day."

It was not my claim that drains should be placed where not necessary or not required. I do claim that drainage, just as I have designed it, will eliminate most of the trouble. This drainage together with a proper thickness of slab or other paving material will obtain good roads.

Now let me say just a word about drainage in general. This subject has become during the last few years so important that the University of Illinois and other state universities have installed courses in Drainage Engineering. Further, I drew the specifications for and built the first Concrete County road in Cook County, Ill. Where drainage is good there are few cracks; in fact, there are but 27 cracks other than expansion joints per mile and I believe that if I could have obtained proper drainage I would have reduced the cracks to 5 or 6 per mile.

I also have a stretch of reinforced concrete pavement 42 ft. wide that is standing up well, though not drained as completely as I would like to have it.

It is a well-known fact among Drainage Engineers that out of 200 experts on Sewer design and construction that but one or two could qualify as Drainage experts.

Mr. Douthitt, no doubt has his streets in Waukegan well sewered, and if properly constructed according to the best sewer design as called for by our leading Engineers, they are built tight so as to admit of no ground water except that coming from drains and the city catch-basins.

A well sewered street is the poorest drained street for this reason: In brick sewers we specify the work well laid in mortar and in tile sewers we specify a hard salt glazed tile with joints sealed. With joints sealed, where does the water in the roadway go? I can show you a street with a 6-ft. brick sewer in the center, 3 or 4-ft. dtiches on the sides with catch-basins 300 ft. apart, and yet trucks sink to the hub on just an ordinary rainy

day and the road is utterly impassable during the rainy season. If Mr. Douthitt were to pave this street, well sewered as it is, he would truly be paving on a sea of floating mud.

Mr. Douthitt writes of foundations of buildings being extended to a depth of 4 ft. to get away from the heaving action of frost. Frost reaches 5 and 6 ft. deep some miles south of Mr. Douthitt's hamlet. I would not want to dispute his expert idea as to depth of foundation, but in my limited experience in soil study and design of foundations, I have always found the upper layers of earth light and not of sufficient density to withstand a load and for that reason we go to a depth where the soil is more dense and can carry the load even if we have to go to rock.

I am again sorry to disagree with Mr. Douthitt's reasoning that waterproofing the subgrade will prevent water from getting up under the slab for the water will get under the slab in two ways. First, as I described in my article, by trickling down over the edge and through the cracks and following under the edge of the slab. This is the capillary water I mentioned in my article, that fine mist or film of water which by its capillary will follow under the slab from the top down the sides and under. All the waterproofing in the world on the subgrade will not prevent this water from undermining the pavement, in fact, if it is not permitted to drain off there is a possibility of there being enough collected to freeze and heave the pavements. Secondly, in waterproofing the subgrade without drainage, what is the action of frost on tar, especially if you impregnate the soil so that all of the pores are filled and compressed to the proper density? Will this stop the heaving due to frost on a water-soaked subsoil?

I have failed to find a place where any covering over water-soaked soil has prevented the frost from heaving the ground and if Mr. Douthitt can refer me to such a location I will be pleased to view same and thank him for his trouble.

Again I will agree with Mr. Douthitt in his experiment with the test tube of earth and the water held by capillary, but the action of the frost in such a case is absolutely nil even in the coldest weather. Such moisture does no damage and the earth will not swell or heave to cause any damage and in my article I did not refer to water coming up from the bottom.

I do not think the Government experts have "exploded" any good idea on roadway drainage and if Mr. Douthitt has a mile or so of pavement constructed without drainage in his city that he is especially proud of I shall be pleased to take a trip there to see it.

I have read in the February issue of Municipal and County Engineering, the discussion of my article by Major Ripley, who I understand is one of the best Highway Engineers in New York. I have no criticism to make though I would like to have had him point out where my theory is wrong. He notes that "blow-outs" occur on hillsides, fills and many other places and he is just as likely to meet them one place as another, all of which I believe can be easily explained. Most specifications call for fill to be placed in layers which are to be puddled, rolled or otherwise compacted.

Suppose we have a fill some 6 to 8 ft. high and we take the soil from cuts or borrow-pits; the top soil is light and the deeper we go we reach a clay which is of a plastic nature; this clay is spread over the fill in layers and rolled. We all know that the center of the roadway is rolled much more than the edges and this plastic clay is rolled until it becomes impervious in the form of a long trough (the extent of the fill.) During the rainy season this trough holds the water; again your pavement floats on a sea of mud and again the frost, here on actual fill, raises and heaves the pavement. The same conditions exist on a cut; the rolling is always more complete in the center and always makes the ground more impervious and again we have a trough or a series of small impervious basins which show up as the frost blows up the pavement.

In fact, the time is coming soon when the draining of the so-called well sewered streets will be necessary or else a much heavier pavement must be laid and I believe the drainage will be the more economical. Very truly yours,

EDGAR A. ROSSITER,
Consulting Engineer.

127 N. Dearborn St., Chicago, Feb. 27, 1922.

WEATHERPROOFING HUDSON RIVER BRIDGE TO SAVE $400,000 ANNUALLY

How an annual saving in upkeep of $400,000 in the proposed Hudson River Bridge will be effected by means of a new and important feature of bridge construction, is described in the Bulletin of

the Copper & Brass Research Association, 25 Broadway, New York. The plan, in brief, is to weatherproof the bridge with bronze.

On this subject, the engineers who have prepared the plans for this colossal undertaking, in a statement just made to the Copper & Brass Research Association, say:

"A new and highly important feature introduced for the first time in a bridge of this great magnitude is that practically the whole of the Hudson River Bridge will be weatherproof.

"That is to say, its steel work will be so completely enclosed with rain-and-moisture-excluding Bronze, that the annual cost of repainting—a most serious item in the upkeep of a big bridge—will be reduced to a minimum.

"That this little matter of protection figures in maintenance economy and is indeed vital, is realized when it is understood that it is expected to reduce the cost of painting, which, if the entire surface of the steel structure were exposed, might easily amount to $500,000 annually, and as only about 15 per cent of the structure will be exposed to the weather, the upkeep will be reduced accordingly."

In the Hudson River Bridge there are a pair of suspension trusses or inverted arches spaced 160 ft. apart, center to center, each truss consisting of 2 cables from 60 to 80 ft. apart vertically, with vertical panels and diagonal bracing between to supply the stiffening under passing loads. From the two suspension trusses vertical eyebar chains are suspended, and carry the double-deck floorway.

On the proper strength, functioning, and permanence of the chains depends the integrity of the bridge. Each eyebar is separated several inches from the adjacent bar, so that it can be inspected at any and all times. Each cable is enclosed in a covering or gallery of bronze for protection and to permit of inspection, so that once the eyebars are painted they will be well protected from the elements.

The chord thus assembled is 11 ft. in thickness, as compared with 15 ins. for the wire cable of the Brooklyn Bridge, and with the enclosing covering is 15 ft: in external diameter.

The estimated cost of the bridge proper has been placed at $100,000,000. By the use of the bronze as a protection against the weather, a yearly saving in upkeep of more than $400,000 is expected.

BUILDING AND MAINTAINING BITUMINOUS MACADAM ROADS IN FRANKLIN COUNTY, OHIO

By Curtis C. Lattimer, County Engineer of Franklin County, Columbus, Ohio.

The Sub-Grade

In preparing the sub-grade, the profile of a road is largely a matter of opinion with the engineer in charge, but the cost must be kept down by eliminating the handling of any more yardage than is absolutely necessary. It is not good practice to plan a long continuous uniform grade, which will necessitate the moving of a large amount of dirt to make your cuts balance your fills, as breaks in grade are not of a serious nature to the traveling public. Moreover, drainage can be improved when a break in grade is made.

It has been found convenient in level country, like Indiana, wherever possible, to follow closely the original contour of the old roadbed. This will greatly reduce the cost of preparing the sub-grade and usually assures better drainage, inasmuch as the water will be drained off according to the original contour of the ground.

Much care must be exercised in the construction of the cross-section of the sub-grade, and it is very good practice to insist that the contractor supply himself with templets made to conform to the cross-section as shown on the plan, which the inspector should use upon the road at least every 25 ft. These templets, unless the sub-grade is to be flat on top, should have the specified crown and care should be taken to see that both sides of the road are level before applying the templet. A separate templet should be used in the construction of the side slopes and ditches, and it is good practice to prepare a sub-grade with bermes 5 ft. on either side of the metal wherever possible, with slopes of 1½ to 1 on both sides of the ditches. The ditches should be 2 ft. in width at the bottom and should be not less than 30 ins. below the top of the finished roadbed. This will allow for any drainage that is necessary in the sub-grade and will, to a certain extent, eliminate a great deal of the moisture under the metal by draining in the side ditches, which is the most disturbing element to any foundation that is built.

Having carefully prepared the sub-grade as mentioned above, we are now ready to construct the base for the roadway.

Waterbound Macadam Base

The construction of bituminous macadam, inasmuch as it is listed under stone

roads, consists of a flexible base course, in which gravel, slag, broken stone, old waterbound macadam or bituminous macadam is used, their value (except old macadam) being in the reverse order as named.

The foundation, however, most generally used is the waterbound broken stone type. I will only give the few details that are necessary to insure a good base course for a bituminous macadam.

The standard specifications which are usually followed in the construction of good waterbound macadam should be most carefully complied with, as the results from the wearing course will largely depend upon the character of the construction of the base course. Extreme care should be taken both in the rolling, screening and waterbinding of this material, and, above all, bermes must be constructed at the same time that the metal is spread, care being taken to see that the berme and the metal is securely bonded together during the process of rolling. Berme boards are used with blocks in the center to obtain the required thickness of metal and the dirt should be thrown against the berme board, which, when removed, will allow it to hold the metal in place, and any irregularities that might appear in the sub-grade can be eliminated by the careful alignment and grade of these berme boards, which are very essential.

Inasmuch as the foundation course, when constructed of waterbound macadam (in order to take care of the present-day travel), should be at least 9 ins. in thickness, it is found preferable to construct two courses, one 5 ins. in thickness and the other 4 ins. in thickness, carefully waterbinding each course, rather than attempting to construct one waterbound 9-in. course, for it is not good practice to attempt to build a waterbound macadam course over 6 ins. in thickness under any conditions.

The size of the aggregate used in the construction of the base should be uniformly graded from 2½ to 4 ins. in size, and although the early idea of some engineers was that a fine material should be used in the foundation course, with the larger material being used in the wearing courses, the reverse is now considered better practice, it being commonly considered that the larger material will insure a stronger base and that the smaller material will insure a more uniform finished surface on completed work. Having completed the waterbound base course the important feature of the bituminous macadam is next considered, namely, the top or wearing course.

Bituminous Macadam Wearing Surface

This wearing course of bituminous macadam (penetration method) should be constructed of not more than 3 ins. when finished, it being better construction to make this course 2½ ins. A material of uniform aggregate from 1½ to 2½ ins. in size should be carefully and uniformly spread, over which a 10-ton roller should make sufficient trips thoroughly to bind this course before any application of bituminous material is applied. The rolling is very essential and should be continued until when a 1,000-gal. automatic distributor used for applying the bituminous material, weighing about 27,000 lbs. loaded, goes over the rolled metal, the metal will not show even the slightest indentation. I mentioned using an automatic distributor, as I think it is far better than by applying by hand, either from buckets or from a nozzle, as it can be much more uniformly spread. Care should be taken to see that the required amount of bituminous material be applied to each square yard, and this can more successfully be accomplished by an automatic pressure distributor than by any other means.

On a course 2½ ins. in thickness it is customary to apply 2½ gals. of bituminous material to a square yard, 2 gals. being applied on the first application, over which a sufficient amount of screenings or chips of suitable material must be scattered, and rolling must immediately take place while this material is still pliable, in order properly to imbed these screenings in any voids that might exist. After this has been completely and thoroughly rolled (and it is almost impossible to over-roll the road after the first application of tar has been made), it is then necessary completely to clean this surface with brooms or a street sweeper, removing all dust or particles that are loosened by this rolling, and one will find that the condition of the road after sweeping presents a much-pitted surface, which in turn must be submitted to a ½-gal. treatment of the bituminous material and chips must again be applied and rerolled. This last treatment is called the seal coat and covers up any voids or small irregularities that may be in the wearing course. It is, however, essential that on a 3-in. bituminous macadam, which may be used instead of the 2½-in., as described above, that a second seal coat of ½ gal. be applied, it being necessary in this case to use about 3 gals. per square yard.

This covers the construction of the bituminous macadam (penetration method) when the improvement is new construction from the sub-grade up, and the maintenance of this type of road, which is one of our biggest present-day problems, will now be discussed.

Under this heading of maintenance the subject divides itself into two classes, namely, construction maintenance and repair maintenance.

Construction Maintenance or Reclaiming the Old Road

Under the topic of construction maintenance it has been found that one of the most successful uses of the bituminous macadam road is in the reclaiming of partly worn-out old waterbound macadam roads. During the past summer Franklin County, Ohio, in which Columbus is located, reclaimed 18 miles of waterbound macadam that was too badly worn out to repair and over which a bituminous macadam, which I have termed a half-sole, was constructed.

In half-soling these roads extreme care was taken to preserve the old macadam roadbed, it being a serious mistake, in my opinion, to spike and scarify the old hardened surface, which would be much better if left alone and the holes filled up, than to be destroyed in an attempt to level them off. An old macadam foundation that is not less than 6 ins. is nearly equivalent to a concrete base, and is much more substantial than a new waterbound base course—so why destroy it?

Our macadam roads in the past have in the most part, especially on our main highways, been constructed not over 16 ft. in width and the great fault was in the construction of a very heavy crown, which it was thought would help the drainage and add to the life of the road. This, however, has been found to be a mistake, and on all the roads that were reclaimed (and I might say that no road is being reclaimed with any other type of pavement than bituminous macadam), we first constructed what I will term a wedge course, over which, if the occasion demanded, a light waterbound course was constructed, if the old metal was not of sufficient thickness to warrant a good foundation, and over this was constructed a first-class bituminous macadam. As mentioned above, it is necessary to take out this extreme crown, which varied from 5 to 8 ins. on the average 16-ft. road, as it is not good practice to use over a 3-in. crown on any road up to 20 ft. in width. On all roads that were reclaimed we not only reconstructed a wedge course and widened where necessary, but also provided drainage along either side of the old waterbound macadam and added sufficient metal to increase the width of our highways to not less than 18 ft.

Two 7-ton trucks passing on an 18-ft. road, each one being on the extreme edge of the metal, allow a clearance of only 2 ft. 2 in., which is not sufficient distance for the ordinary truck driver, who sits very high and sometimes is handicapped by riding inside of the cab. In discussing this matter with truck drivers it was found under ordinary travel that they figure on about 3 ft. clearance between passing vehicles, and it would therefore necessitate that a 20-ft. road be constructed if they are to remain on the metal in passing.

Great damage can be done to the bermes, which in turn hampers the drainage into the side ditches, when the travel begins to tear up and rut the space between the metal and the ditches. It is therefore recommended that no road should be built at the present time less than 18 ft. in width, and wherever possible 20 ft.

The 18 miles of road reclaimed during the past summer by half-soling, which in all instances were widened and a wedge course constructed and in some cases an entirely new waterbound course built, over which a standard 2½ to 3-in. bituminous macadam was laid, cost on the average about $14,000 per mile, which is comparatively cheap when you consider the excellent roads that we now have compared to the old worn-out macadam.

All work on the reclaimed roads was performed by the county itself, all labor being employed and all equipment being owned by the county. This feature of "construction maintenance or reclaiming the old road" is very commendable at the present time, inasmuch as there are so many miles of important highways which can, at a moderate cost, be reclaimed and made into first-class highways, and the most satisfactory results are obtained from the bituminous macadam type.

Repair Maintenance

In discussing the last phase of the bituminous road, namely, repair maintenance, it is safe to say that the success of this class of work depends very much upon the organization and system used. I have found that in a district where considerable bituminous macadam exists, especially so in my own county, in which there are about 400 miles of same, that it is necessary to divide the county into patrol districts, over which a foreman

must be placed, whose duty it is to supervise all bituminous improved roads in his district and give them immediate repair when they begin to show their first signs of wearing out. These foremen should employ from 4 to 5 men and be equipped with trucks and suitable tools, and should carefully survey all the roads in their districts at all times, patching each hole as it appears, taking care of any obstruction in the way of drainage, building protection fences where necessary, and doing whatever work is imperative for keeping roads in good condition.

The bituminous macadam road is the most easily maintained road we have, inasmuch as the repair material is very easily applied, quickly conforms to the uniform surface of the road, and unites itself with a good bond; this is not true in patching any other type of road. The small holes as they appear are thoroughly swept with hand brooms and are then painted with a bituminous material on which is applied the repair material, which consists of ¾-in. stone mixed with bituminous material, which is carefully tamped into place with hand tampers, over which dust or any other available material can be thrown to keep travel from unraveling it until it gets its initial set. Travel quickly wears this material into place, and after a day or so it is almost impossible, outside of probably a difference in color, to locate these patches on the road.

It is found very expedient to install patrol depots, where this material may be mixed in large quantities with concrete mixers, and after it is thoroughly mixed it is dumped onto drying platforms, where it is allowed to season for about three days until it begins to take on a stable condition, at which time it is applied to the road.

It can readily be seen that this is the easiest and most suitable method for the repairing of bituminous macadam and the cost under this system of thoroughly patroling and maintaining about 400 miles in Franklin County during the past summer averaged about $300 per mile, which in my opinion is a conservative figure for this class of work and compares most favorably with the cost of repair on any other type of road.

Surface Treatment

In addition to this type of repair work it is also necessary, on bituminous macadam roads, to surface treat with from 1/3 to ½ gal. of bituminous material per square yard about every two years.

During the past summer 125 miles of roads, in addition to the repair and maintenance, were surface treated by an application of bituminous material in the amounts as mentioned above, over which a light course of pea gravel or chips was applied, which protects the wearing course of the bituminous macadam to a very great extent. This expenditure averaged about $650 per mile and the work was also done with county help and equipment.

The bituminous macadam road should be classed with the heavier types of road, and considering its initial cost of construction, together with its cost of maintenance, it is, in my opinion, the cheapest good road that can be constructed today.

The foregoing is from an address by Mr. Lattimer delivered before the Eighth Annual Road School of Indiana, held at Purdue University, Jan. 24, 1922.

COOPERATION BETWEEN STATE AND COUNTY HIGHWAY DEPARTMENTS IN INDIANA

By C. Gray, Chief Engineer, Indiana State Highway Commission, State House, Indianapolis, Ind.

The Indiana "County Unit Road Law" provides for the approval by the State Highway Commission, of county plans and specifications as well as the inspection of the construction, where proper application is made. While some of the plans and specifications come to us prepared in a manner that requires but few changes, many are so loosely drawn up that they would permit the contractor to use any quality of the material specified that he desired, as well as perform the work in any manner that he should see fit. It is often our misfortune to be called upon to inspect the construction of roads where we had nothing to say relative to the plans and specifications, and we are expected to secure a first-class road of the type called for regardless of the fact that often the specifications provide for a poor quality of material and permit the contractor to perform the work in the cheapest manner possible. We also have cases where the taxpayers are dissatisfied with roads after their completion, and apply for State inspection, expecting us to be able to tell whether the materials used and work performed meet the specifications after the materials have been incorporated in the work and the work completed. If this could be done, we could save the State and counties thousands of dollars, as it would not be

necessary to keep inspectors on the work during its progress. In no case will we assume responsibility for work which was completed prior to the assignment of our representative.

The Taxpayers' Interest

The taxpayers who are interested in securing a dollar's worth of road for each dollar expended, and they should all be interested, should take an active interest with the beginning of the survey and assure themselves that the plans and specifications provide for the best construction of the type selected that can possibly be secured with the funds available. When a newly constructed road fails, the blame is usually placed against the engineer, which in many cases is unjust. The contractor, when placing his bid, bases it upon the prices of the material and the amount of work provided for in the plans and specifications and, in many cases, if he performed the work according to the letter of the specifications, good construction would not be secured. In order to secure satisfactory work two things are absolutely necessary, namely, adequate plans and specifications, and rigid inspection.

Fundamentals in Preparing Plans and Specifications

The following are fundamentals that should be taken care of in any set of plans and specifications:

Type

The selection of the type of pavement causes more controversy than any other phase of highway construction. It is a phase on which the material concerns spend thousands of dollars in salaries to promotion men, and in literature in an effort to educate highway officials. It is needless to say, however, that such educational efforts are confined to types calling for their particular material. In justice to the different material concerns, however, it should not be forgotten that they have through research and study aided materially in bringing the standards of the different types of pavement to the place they have reached today. They will also aid in the future by working in harmony with the laboratories and research departments of the different states, as well as the National Research Council. Considering the subject in a general way, that is, with regard to a rigid and non-rigid type, it is not such a difficult problem if gone about in a systematic manner. Take the State of Indiana, for instance. The State Highway Commission has laid out a system of approximately 4,000 miles. The most enthusiastic good roads booster would have to admit that an attempt to reconstruct each and every mile of this system with a rigid, or as it is commonly termed, a hard-surfaced type of pavement, would be absurd. Ultimately, this may be done, but such a time is far in the future. It is the intention of the commission, carrying out the policy of Governor Warren T. McCray, to "hard surface" the primary system or main trunk lines only. If this is done, the traffic from the secondary roads will concentrate on the paved roads and make it possible to maintain the secondary system of non-rigid roads at low cost. It is often erroneously stated that our gravel and stone roads could be utilized as a base for our hard surfaced roads. If these old roads had originally been constructed on the proper alignment with proper grades and to the full width of our standard pavements, they would make excellent sub-base for any type of hard surfaced road. Due to the necessity of grade and alignment changes, and the narrow width, however, we even find it impractical to attempt to salvage the old metal for shoulder material. The construction of our secondary system of non-rigid types where new construction is necessary. will be constructed with ultimate alignment and grades, in which case they will be valuable as a sub-base in case the intensity of traffic should, at a future date, justify a hard surface.

The selection of a particular non-rigid or rigid type is the real problem presented by the type phase of highway construction. This selection can be made intelligently after a careful study of the cost, local materials available, present traffiic, and the expected intensity and kind of traffic after the construction is completed. Comparison of roads built of different types by highway officials should be gone about cautiously. Such comparisons are usually conducted by material interests and quite naturally the best examples of their particular type are selected, and the poorest of the other types. Such comparisons are valuable if made independently of any material interest, providing information is obtained relative to plans, specifications, cost, etc. Every type of road has been abused by poor engineering and poor construction, and incompetent contractors.

Plans

Plans for new construction should show all details of construction, such as old and new right-of-way line, center line of construction, curve data, location, size

and type of structures, structures to be removed, all special features such as retaining walls, ditch protection, guard rail, etc., and cross section of finished road, etc., in such a manner that the contractor will have a clear understanding of the amount of work to be done in order that there can be no misunderstanding after the contract has been awarded. The profile should show the present ground line and the proposed grade line with the percentage of gradient of proposed grade and grade elevations at each break in grade. In addition to this, cross sections of the old roadway should be taken at least each 100 feet, and plotted on special cross section paper, the proposed sections of the new roadway plotted at corresponding stations, and the amount of excavation and embankment computed by the use of a planimeter and average end areas. Structural plans should show all dimensions, minor details and other information in a manner that will leave no doubt as to the size, materials to be used and the kind of workmanship provided for.

Highway plans have been submitted to the state highway commission for approval with no right-of-way shown and after checking up on the ground, we have found that it would have been impossible to build shoulders and ditches as provided for in the plans on account of insufficient right-of-way. We have also had cases where no elevation of the old and new grade line were shown which would have permitted the contractor to do the minimum amount of grading necessary to prepare a sub-grade upon which the surfacing could be placed, regardless of the resulting gradients. A very common and inaccurate method of computing earth work, is by a method known as center heights. In this method, it is generally assumed that the depth of cut or fill on the center line is the average for the entire width of roadway. It does not take an engineer to see that by this method a contractor may be paid for thousands of yards of excavation which he does not move, or he may be required to move more than the estimate shows. We have also eliminated retaining walls shown on plans costing up into thousands of dollars by making a slight change in grade and alignment. In one case we were called upon to inspect the construction of a road where the plans called for structures of a certain type, the only information being that they should be reinforced concrete, no mention being made of the quality of materials, amount of cement or steel.

Specifications

Specifications should define all terms used in a clear and concise manner, give instructions to bidders and in the general provisions should deal with special work, alteration of work by the engineer, extra work, unauthorized work, progress of work, character of work and equipment, observance of laws, sanitary provisions, public convenience, preservation and restoration of public utilities, property, trees, etc., contractor's responsibility for damage to persons and property, as well as for sections of road opened to traffic prior to acceptance, use of materials found on work, final cleaning up, etc. The construction details should clearly outline the method of doing the work as well as specify the grading and quality of materials, setting forth the method of testing them.

The state highway commission has prepared and had printed, standards governing the form and arrangements of plans, specifications and estimates for county projects, which set forth all items which should be provided for and the arrangements of them. The State requires the counties applying for State approval of plans or specifications to comply with these standards before approving any plans or specifications. These standards are practically the same as outlined by the United States Bureau of Public Roads to the States for plans and specifications on Federal aid roads.

The State has also drafted specifications for all of the standard types of rigid and non-rigid roads, which are available for county officials. These specifications have all been approved by the Bureau of Public Roads and comply with their standards. Section 39 of the County Unit Road Law, enacted in 1919, states that "no materials shall be used in the construction of a highway, bridge or culvert in the State of Indiana, unless such material shall be equal to the material required and shall meet all tests and standards as required by the state highway commission as suitable for the building of highways, bridges or culverts by the state highway commission." The standardizing of highway materials, especially the grading of gravel and stone for the different types of highway construction, would have many advantages. At present there are about as many gradings as there are counties in the State. This means additional equipment for the stone and gravel plants and a continual change of screen arrangements. Standardization would prevent the introduction of "freak"

specifications under which it would be impossible to build a durable road. There are cases, however, where the intensity of traffic and funds available would not warrant the building of a standard type road. In many such cases it is possible to secure the material from local pits using the natural deposit, or crushing stone along the roadside. In this manner a road which will answer the purpose can be secured at a very low cost.

Cost

The common but erroneous manner of comparing the cost of a certain type of road in one locality with the cost of the same type in a different locality, by using a mile as the unit to state that a certain type of road should cost a certain amount per mile, is absurd. The cost per mile varies with the length of haul from the nearest railroad siding, freight rate, amount of grading, number of drainage structures and many other items. It is only after a careful study of these conditions that one is in a position to judge whether or not the cost of a road is excessive. It should also be remembered that the lowest bidder is not necessarily the best. Contracts should not be awarded until a careful investigation of the low bidder's equipment, financial condition, competency and past reputation has been made.

USE OF CALCIUM CHLORIDE IN ILLINOIS HIGHWAY WORK

A circular to contractors on the use of calcium chloride on road work in Illinois was recently issued by B. H. Piepmeier, Engineer of Construction of the Illinois State Highway Department, Springfield, Ill. The circular, which is of general interest, is here reproduced:

Calcium chloride should be purchased in granulated, flaked or powdered form, either in steel drums of approximately 350 lbs. capacity, or in specially prepared cloth bags of 100 lbs. each. (The 100-lb. bags are usually preferable.) All material should be purchased with the guarantee that it contains from 70 to 75% calcium chloride.

Quotations received in this office during the month of January, 1922, indicate that calcium chloride can be purchased by contractors for $27 per ton, f. o. b. plant. Terms: 30—1% 10 days.

Incorporating in the Mix to Hasten the Set and to Prevent Freezing

The Department will permit the use of calcium chloride in the concrete mix for road construction during cold weather. When used, the solid, granulated, flaked, or powdered material shall be thoroughly dissolved in water. The proper amount of water should then be added to the mixer drum before the aggregates enter it. When used for paving work, not more than 2% by weight of the cement shall be used. Calcium chloride should not be used in a pavement that crosses an electric railroad, and its use should be discontinued approximately one-quarter of a mile from the electric railroad crossing. There is no objection to using the material when the highway parallels an electric line.

It is not definitely known at what temperature concrete will freeze when the 2% of calcium chloride is mixed with the concrete. It is advisable, therefore, to arrange to cover the pavement with loose straw or earth just as soon as it has taken sufficient set to prevent marring of the surface when the covering is added. The use of the calcium chloride will hasten materially the setting process of the concrete, and enable the pavement to be covered in a very few hours after it has been finished. This will, therefore, remove a large percentage of the risk contractors take in placing concrete late in the fall when the temperature is likely to drop very suddenly.

The calcium chloride should not be used in bridge or culvert construction. Where it is necessary to place concrete in culverts or bridges during freezing weather, the materials or water should be heated before mixing, or some arrangement provided for heating the materials in the drum while the concrete is being mixed. The concrete should be mixed to a temperature of at least 50 deg. Fahrenheit when it enters the bridge forms, and should then be protected by canvas or straw to prevent it from freezing.

In all cases concrete in roads, bridges or culverts should be kept from freezing for a period of at least 5 days.

Its Use on the Surface of Pavements for Curing

Calcium chloride may be used in connection with the curing of pavements. If three pounds of the material are applied on each square yard of pavement no water or earth will be required. The calcium chloride material can be distributed uniformly over the surface of the finished pavement by means of a mechanical drilling device or by the use of a shovel and long handled broom. The surface shall

be covered just as soon as it will support the material without marring the concrete. The granular or flaked material shall be used for curing purposes as it will not be disturbed readily by rain or high wind. The treated surface should be protected from rain for at least 48 hours or additional applactions should be made following rains to insure 3 lbs. per square yard of surface for a period of 48 hours. The calcium chloride can be used to an advantage at points where it is difficult to secure sufficient water to do the curing, or where it is impossible to get enough straw or earth for the covering.

The water line may be omitted on jobs where central mixing plants are operated, and calcium chloride is used for curing. During dry weather the subgrade may be kept moist by the use of sprinkling wagons at night, and during the noon hour by hand sprinkling from barrels along the roadside, or from applications of the calcium chloride direct upon the subgrade.

Hair checking of the finished pavement should be prevented by keeping all aggregate moist, by keeping the surface moist with water spray, or by the use of wet burlap laid directly upon the surface of the pavement prior to the appearance of the checks.

There should be provided on all jobs sufficient burlap or canvas to cover all pavement that is not covered with earth or calcium chloride. Burlap may be used to protect freshly laid concrete from rain, and may be laid directly upon the surface of the pavement before the final set takes place if it is done carefully. Canvas should in no case be used on the pavement until the concrete has set sufficiently to prevent marring of the surface.

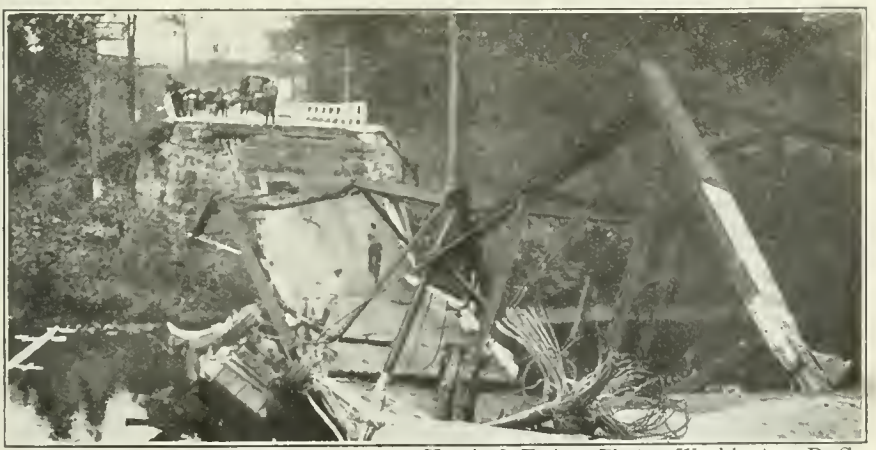
SPEED IN RECONSTRUCTION OF A HIGHWAY BRIDGE

By Daniel B. Luten, Bridge Engineer, Indianapolis, Indiana.

A steel truss bridge of 101 ft. span across the Little Patuxent River, at Savage, Maryland, collapsed as the result of a collision on Sept. 21, 1921. Its width of roadway was but 13 ft. and it bore a warning notice that it was a "One-Way Bridge;" nevertheless, a truck and a runabout attempted to pass on this narrow roadway and collided, throwing the truck through one of the trusses, breaking its verticals and bringing down the entire structure, as shown in Fig. 1.

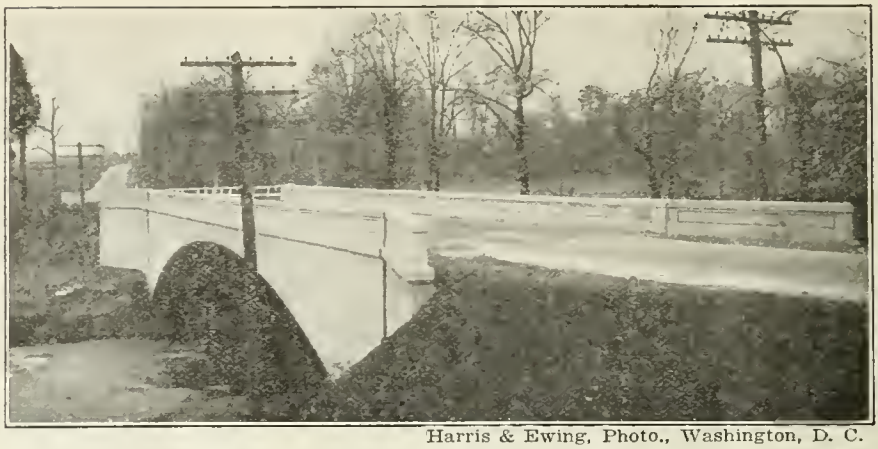
The truck is lying in the bed of the river, while the runabout was rescued from the abutment, where it hung suspended after the crash. Three men and two women were passengers in the automobiles, but escaped without serious injury. The American Telephone and Telegraph Company's, cables carrying the 300 wires connecting Washington with all cities north, were severed when the bridge fell. The cable is shown in the foreground of Fig. 1.

This bridge was a very important structure on the Washington Boulevard between Baltimore and Washington, probably the most heavily traveled highway connecting the North and the South. Washington Boulevard is a Maryland State road, under the supervision of the Maryland State Roads Commission, and the importance of traffic over it, together



Harris & Ewing, Photo., Washington, D. C.

FIG. 1—COLLAPSE OF LITTLE PATUXENT RIVER BRIDGE, SAVAGE, MARYLAND.



Harris & Ewing, Photo., Washington, D. C.

FIG. 2—VIEW OF NEW, LITTLE PATUXENT RIVER BRIDGE AT SAVAGE, MD., LOOKING TOWARDS WASHINGTON, D. C.

with difficulty of suitable detouring, made it essential that immediate reconstruction should he accomplished wlth the least possible loss of time. The State Roads Commission, therefore, consulted contractors at once and asked for proposals for rebuilding, in which speed of construction was to he a most important consideration.

The old bridge collapsed on Wednesday, Sept. 21. The Luten Bridge Company, of York, Pa., was telephoned that same day and asked to have a representative at the bridge slte promptly to estimate cost of reconstruction. The representative was at the bridge site Thursday and made investigation, and that night, Sept. 22, sent a 125-word night letter to the Luten Engineering Company, at Indianapolis, Ind., who are designing and consulting engineers for the Luten Bridge Company, but otherwise have no interest in the contracting company. The telegram gave data for designing, and asked for quantities, details on which contract might be based, and that complete working plans be mailed on Saturday, Sept. 24.

On Friday, Sept. 23, a 36-word telegram was sent from Indianapolis hy the engineers, giving quantities and details for a 97-ft. reinforced concrete arch to replace the collapsed bridge, and on Saturday, Sept. 24, only three days after the accident, the contract was awarded to the Luten Bridge Company for the new structrue on details supplied by the telegram and to be confirmed by the plans to be received at Baltimore Monday, Sept. 26. The contract was awarded in competition with other proposals made by other contractors.

Immedlately on award of contract the Luten Bridge Company began shipment of equipment to the site and on Monday, Sept. 26, work was under way, with men excavating in each abutment. The working drawings were malled from Indian-

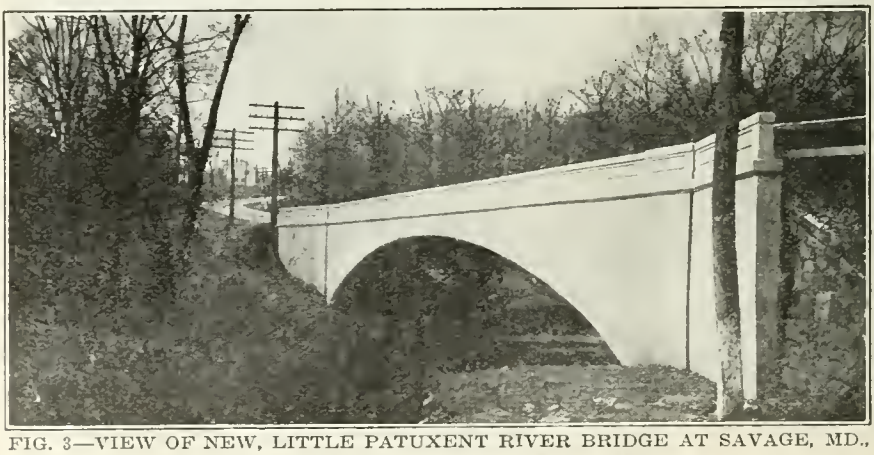


FIG. 3—VIEW OF NEW, LITTLE PATUXENT RIVER BRIDGE AT SAVAGE, MD., LOOKING TOWARDS BALTIMORE, MD.

apolis on Saturday, Sept. 24, and received at Baltimore Monday, Sept. 26. On Oct. 6 the two abutments were poured, and on Oct. 10 the arch ring was begun; it was completed Oct. 12. The first spandrel wall was concreted on Oct. 15 and the other was begun Oct. 17. Backfilling was commenced on the 19th, and on Oct. 22, at noon, traffic was turned over the bridge, 26 days after collapse of the old bridge. The macadam roadway was laid for the full width of roadway on Sunday, Oct. 23.

The completed bridge is shown in Figs. 2 and 3, which are taken looking, respectively, towards Washington and towards Baltimore. The arch has a clear span of waterway of 97 ft., height from stream to roadway of 18 ft. and roadway 24 ft. wide. The contract price was $19,000, a reasonable price even for the speed attained in construction. The force employed ranged from 20 to 35 men and the bridge was opened to traffic eight days ahead of the schedule promised. The time required for construction was short as compared with the time usually required for such structures, but the entire time between collapse and replacement is particularly remarkable in showing the efficiency of a Highway Department in eliminating preliminaries and getting results in award of contract and execution when the public interests imperatively demanded it.

UTILIZING SMALL STREAM VALLEYS FOR TRAFFIC ROUTES

By Jay Downer, Engineer and Secretary, Bronx Parkway Commission, Bronxville, New York.

The valleys of our larger streams are so commonly used for traffic routes that it is quite unnecessary to call attention to their advantages. This discussion is, therefore, limited to the protection and use of small stream valleys in the vicinity of centers of population. In the beginning we may as well face the fact that every small stream valley in or about a center of population is destined to be either a substantial asset or a definite liability to the city through which it flows. If it is taken in hand, protected and utilized, with marginal lands acquired by the municipality, it will usually afford excellent location for traffic routes, trunk sewer lines and parkways, which will substantially increase property values in its zone. While on the other hand, if left to shift for itself, unprotected, such a stream valley is almost certain to degenerate into a nuisance zone with distinctly depressing influence on property values and with the growth of population, presenting an increasingly difficult problem, which ultimately must be solved at a cost for abating the nuisance, which may easily be many times the cost of providing a parkway and important traffic route, if reasonable foresight had been exercised.

The Bronx River Parkway.

As an illustration of the general problem, I will describe how a particular case —that of the Bronx River in and adjacent to the City of New York—has been reclaimed and utilized for what is destined to become one of the world's greatest pleasure traffic routes—the Bronx River Parkway.

The Bronx River Parkway Reservation extends for a distance of 15 miles, from the Botanical Gardens of Bronx Park in New York City, to the great Kensico Dam, four miles north of White Plains, the county seat of Westchester County. The Bronx River is a small stream coming down out of the Westchester hills and emptying into Long Island Sound. It has a beautiful valley between ridges roughly parallel north and south. Bold and rocky in some places, there are expanses of meadow land in other portions; in short, the diversity of scenery that Westchester County is noted for. The New York and Harlem Railroad closely follows this water course and with the development of towns and villages along this railroad, there came the inevitable sewage pollution and discharge of factory wastes. The Bronx River went from bad to worse year after year and served as a channel to convey the accumulated filth of the valley towns such as White Plains, Mount Vernon and the upper portion of Bronx Borough, into Bronx Park, through which the river flows and enlarges into several small lakes. Unfit for decent human habitation, the river banks in the towns were cluttered with stables, shacks and small factories, which with the stream itself formed an unsanitary nuisance affecting extended areas.

Good Advice as Hard to Take in 1895 *as in* 1922

More than 25 years ago, in 1895, the polluted condition of the Bronx River attracted sufficient attention to bring about the appointment by the Governor of an Investigating Commission. This Commission employed an Engineer, who wisely

recommended that the low lands along the river be acquired, not only fully to protect the river from pollution, but to provide ample width for a trunk sewer and important traffic route or Parkway Drive. The shortsightedness of those Commissioners in refusing to adopt the recommendations of their Engineer has cost the people of New York City and Westchester County many millions of dollars, for if the Parkway had been established at that time, the necessary lands could have been acquired at a mere fraction—certainly not more than one-fifth—of the present cost. The 1895 Commission recommended instead that a sanitary trunk sewer be built parallel to the river. The question of enclosing the entire river in a big storm sewer was discussed, but discarded, it being impracticable to build a storm sewer large enough to carry the flood waters. That Commission's recommendation to expend a large sum for the construction of a sanitary sewer did not appeal to the public imagination and nothing resulted therefrom.

Ten years elapsed and it became absolutely necessary from a sanitary standpoint to clean up the situation. Another investigating commission was appointed in 1906, which recommended that the most feasible solution, having regard for economy and return in public utility, was the creation of a Parkway Reservation, which would include the low lands and immediate slopes along either side of the river. The Commission pointed out that this was the cheapest way to protect the river and that the land to be acquired would provide locations not only for sanitary sewer, but for a great Parkway with traffic artery extending from New York

BEFORE AND AFTER ENGINEERING TREATMENT.

Swampy Area in Bronx River Parkway Reservation Near Woodlawn, New York City. Lower View Shows Finished Parkway Drive at This Point After Swampy Area Was Drained and Graded.

City's park system 15 miles along the picturesque river to the magnificent Kensico Dam and Reservoir, where the City owns 4,500 acres of beautiful woodland and lake areas. These recommendations were adopted as a joint project of New York City and Westchester County, and the legislative act provided for acquiring about 1,200 acres of land along the river, elimination of sewage pollution and development of a Parkway.

Delay of 25 Years Costs Six Million Dollars

With the passing of time there had been a steady increase in land values in all suburban districts around New York City and lands in the Bronx River Valley, which could have been acquired a few years earlier at much lower cost, had so advanced that the 1,200 acres worth 25 years ago, perhaps, one and a half to two million dollars, are now costing, in spite of the utmost economy in acquisition, upwards of $8,000,000. In the meantime, the natural beauty of certain sections of the valley had been almost totally destroyed and the restoration of these sections has added to the heavy cost of delay in starting the project. The Parkway Commission, however, made the best of the situation and as soon as the lands were acquired, the nuisances were abated, garbage and refuse cleaned up, and over 150 cases of pollution were eliminated. With the river and Reservation finally clean, the Commission found itself in 1919 with funds in hand for proceeding with the improvement program, the main feature of which was the construction of a Parkway Drive, 40 ft. in width, connecting the City's boulevards at Bronx Park with the magnificent system of State roads diverging from the northerly terminus of the new Parkway at Kensico Dam.

This 40-ft. driveway located in a Parkway Reservation varying in width from 200 to 1,200 ft., with an average width of 600 ft., will provide an outlet for pleasure traffic of tremendous value to the great metropolis. The work of constructing the driveway is about one-half finished and the traffic on the sections already opened indicates that the driveway will be used to capacity when completed at the end of 1923.

The accompanying views suggest better than words could describe the conditions along the Bronx River at the beginning of the work and the changes which have been brought about through elimination of nuisances, removal of the 355 shacks and third-rate buildings, drainage of swampy areas, regulation of river, filling and grading, and finally the construction of bridges and paving of the driveway with concrete base and asphaltic surface. I trust that the "before and after" views, showing conditions which naturally obtain along a small stream within the environs of a city, and the way in which such a nuisance zone can be turned into a tremendously valuable asset, will carry home the point that I have already so strongly emphasized; namely, the necessity of protecting and utilizing the small stream valleys in and around our cities.

The foregoing paper was presented by Mr. Downer at the recent annual meeting of the American Road Builders' Association.

REMEDIES FOR SOME COMMON DEFECTS IN ROAD CONSTRUCTION

By B. H. Piepmeier, Engineer of Construction, Illinois Division of Highways, State House, Springfield, Ill.

The most vital error that we all make as engineers and contractors is that of misunderstanding the plans and specifications. We are all too much inclined towards substituting or advancing our personal ideas for those of the purchaser or the official agent, representing the purchaser. It is not uncommon to find gross errors creeping into both road and bridge construction which could have been avoided had the plans and specifications been thoroughly understood and followed.

The average engineer and inspector can be severely criticised for not conveying more information concerning the plans and specifications to the contractors, superintendents and foremen. The intention of all contractors is to do good work, but to do it as economically as possible. The contractor in the majority of cases has much better knowledge of the requirements of the plans and specifications than the average superintendent or foreman. However, it is impossible for the contractors to be on the work at all times; hence, he is required to transmit his information to his superintendent and foremen. These men are often over-zealous concerning their work and pay more attention to economy than to the character of the work. The results, therefore, are that the men directly responsible for the work are filled with the desire of economy and are not studying the plans and specifications as they should. Under these

conditions it is evident that the first duty of the supervising engineer is to keep before the superintendent and foremen the fundamentals of the plans and specifications as well as his idea as to the way the work may be performed to comply with the wishes of the purchaser.

It is suggested that the supervising engineer take every possible opportunity to educate the superintendents, foremen and head men on various parts of the work concerning the requirements of the plans and specifications. Experience has shown that on jobs where the foremen and laborers are familiar with all of the requirements of the engineer, and the specifications under which they are working much more satisfactory results are obtained.

After a special effort has been made to familiarize everyone on the job with all details and requirements of the plans and specifications, there are many operations which must be watched carefully to avoid defective work.

The engineer must recognize the seriousness of errors and accordingly check all of his survey work to insure that stakes have been set exactly in accordance with the plans. The balance points in the earthwork should then be prominently marked to guide the grade foreman. "Split hair" methods should be avoided in setting stakes and more reliance placed on judgment and the use of the eye to catch gross errors. The eye can be quickly trained to determine whether or not the improvement fits the location. Stakes should be set so that the contractor can provide proper superelevation for all curves when the loose grading is being done. Do not depend upon the grade foremen to know that the curves are to be superelevated or to know the amount of superelevation that is to be put on in each case.

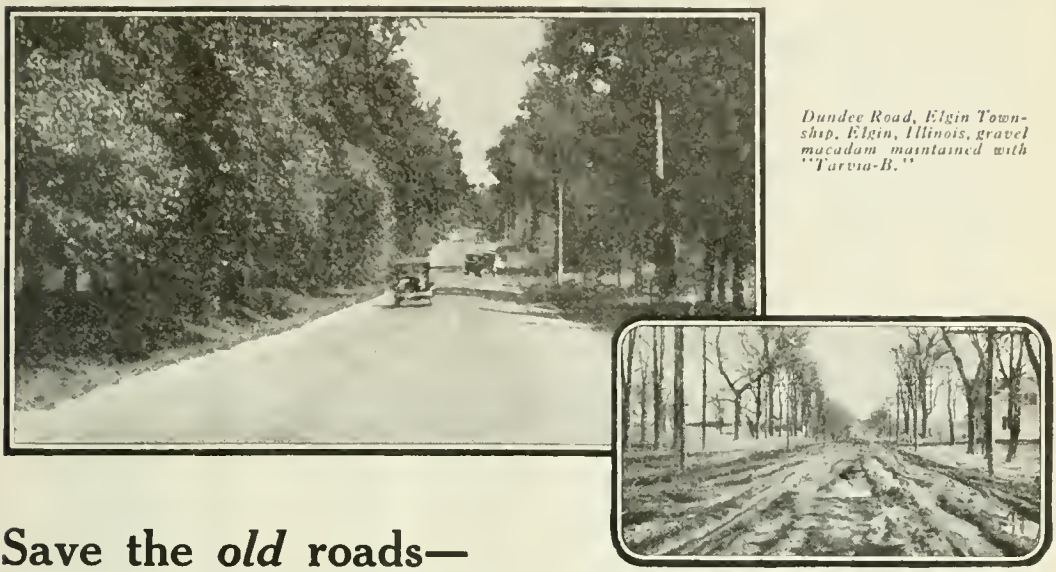
When the subgrade is being prepared, many contractors forget the advantages of good surface drainage. Poor drainage will result in deep ruts, soft spots, and frequently a high subgrade that will be difficult to handle when the road is being laid. Often an inferior subgrade or road bed is the result of insufficient maintenance during the construction of the road. Many mistakes are made by contractors in not having tools suitable for proper maintenance of the roadbed during construction.

In the construction of pavements the inclination of both the contractors and the engineer is to over-roll the subgrade. The 10-ton 3-wheeled roller on moist clay or black loam soils will compress the subgrade from 1 to 2 ins. below its normal compactness. When the subsoil is over-compacted it is sure to cause undue cracking of the pavement slab. The light roller that smooths the subgrade and mashes the clods is considered better. The subgrade that has been thoroughly saturated with water has ordinarily acquired its proper stability and is best for pavement construction without further rolling.

Rolling of the subsoil beneath the forms can be highly recommended. Very frequently side forms for pavement construction are set on loose earth and the results are undue settlement and uneven pavement surfaces and pavements that are not the required thickness. Crooked and bent forms are also the cause of many waves and uneven places in the finished work.

In concrete construction more defects in the finished work are directly chargeable to non-uniformity of mix than any other one thing. A special effort should, therefore, be made by the contractor to insure a uniform and sufficient water supply for the mixer and the curing. Accurate measuring of all batches is one very sure way of securing a uniform consistency in the mixed concrete. The concrete should also be deposited upon the subgrade so as to insure further uniformity. Concrete that is discharged from a paving mixer having a chute delivery is inclined to separate the coarse and fine aggregate when the mix is a little too wet. When chute machines are used, therefore, extra puddlers behind the mixer should be employed and then trained to spread the concrete in two or three layers in building up to the required thickness of the slab. If this is not done there will be alternate windrows of coarse and fine aggregate and the pavement will not only be weakened but will have a poor riding surface.

Tamping and finishing is one of the most important operations in connection with concrete road construction. The value of many roads is judged by their riding qualities. The public is entitled to the smoothest road that is possible to build; hence, more care should be given to this operation of the work. Too much machine tamping will result in bringing a surplus of mortar to the top, which is unsatisfactory and will disturb the line and grade of the forms. A surplus of tamping particularly on grades and superelevated curves will cause the concrete to flow and thereby become wavy. On steep



Dundee Road, Elgin Township, Elgin, Illinois, gravel macadam maintained with "Tarvia-B."

Typical Spring conditions on a soft-surfaced road

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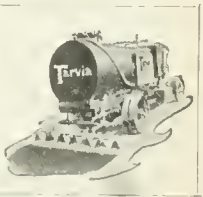
This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.



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grades and superelevated curves very little machine tamping should be done. Under such conditions, hand finishing with a long handled float, having a blade of not less than 4 ft. in length, should be used continuously.

The side forms should be kept clean. A surplus of concrete being constantly pushed over the forms is an unnecessary waste of material and a direct cause for much unevenness in the finished pavement.

Hair checking in the finished surface of a concrete pavement is the result of many different causes. It is impossible to prescribe a specific remedy for hair checking. It is primarily caused by the rapid drying of the surface of the pavement. Any method, therefore, that will retard the drying of the surface will assist in preventing cracks. When the surface is cracking excessively special care should be taken to keep the aggregates thoroughly saturated with water and to keep the surface of the pavement covered with wet burlap. A fine spray of water upon the surface will also prevent very largely the hair checking of the surface.

Header boards are also the source of many defects. In the majority of cases the most uneven portion of a finished pavement occurs adjacent to the construction joints. Extreme care should, therefore, be exercised in the setting of joints and header boards to eliminate defects. Header boards should be corrugated or deformed in such a way as to form an interlocking joint in the pavement. Before the concrete sets adjacent to the construction joint the surface should be carefully checked with a 10-ft. straight edge and all uneven places corrected by the use of the long-handled float.

On practically all work a fair profit could be saved in the elimination of all wastes about the job. A clean-up man is frequently provided and his duties are to see that all cement sacks are cleaned properly and bundled and returned to the shipper. He also looks after the waste aggregates, engineering stakes, lumber, and incidental tools and materials used on the job. The effort put forth to keep a job clean is many times repaid by the amount of materials saved and the spirit that is impressed upon the workmen.

The foregoing is from an address by Mr. Piepmeier, delivered at the recent short course in Highway Engineering held at the University of Illinois.

IMPROVED STREET LIGHTING AT REDUCED COST IN SCRANTON, PA.

The city of Scranton, Pa., is now completing the installation of an entire new street lighting system, substituting some 1,300 arc lamps with gas-filled electric lamps, each giving about 40 per cent better street illumination than the discarded arc lamp. The cost per lamp to the city is 20 per cent less than the city paid the local electric company for the past 20 years. The lamps are installed, free of charge to the city, by the local electric company.

The plan for these new lamps was devised and specified by Frank Koester, consulting engineer and city planner, 57 West Tenth St., New York City. With his assistance the city entered into a new 10-year contract with the electric company, and a cash saving to the city of some $65,000 was effected, in addition to securing 40 per cent better light. This cash saving was not effected at the expense of the local electric company, because the new lamps consume less current. In fact, the electric company has a greater net profit than before.

In addition to the above suspended lamps, Scranton will have completed soon an underground-fed ornamental boulevard lighting system of 110 lamps, as planned by the consulting engineer, of 400 mean horizontal candle power each, at $50 per lamp per year.

Since Mr. Koester completed his work on this street lighting system he has been retained by the city of Scranton to make a Comprehensive City Planning and a Zoning Report. The zoning covers the entire area (20.5 square miles) of the city, while the city planning covers the area of the city and the territory of three miles beyond the city limit—that is, the jurisdiction of the Department of City Planning.

VALUABLE TRADE LITERATURE

Handbook of Truscon Steel Sash.—A book of 80 pages containing standard dimension tables, architectural details, specifications and more than 20 pages of illustrations of Truscon Steel Sash is manufactured by the Truscon Steel Co., Youngstown, Ohio. Engineers, architects and contractors, who received advance copies for criticism, declare it to be the most practical and handy reference book ever printed on steel windows.

WATER WORKS SECTION

SYMPOSIUM ON THE CENTRALIZED SOFTENING OF A PUBLIC WATER SUPPLY

(Editor's Note: Believing that the next great development in the water works art is destined to be in the centralized softening of public water supplies, where the raw water is undesirably hard, we invited several prominent water works engineers to discuss the subject for the benefit of our readers. Several very interesting letters on the subject are here presented.

Perhaps it will be serviceable to the reader to know that we asked these authorities the following questions:

"In the present state of the art of water softening do you consider it economically feasible to soften an entire public water supply at a central point before it is distributed to the consumers? That is, is it cheaper to the average water taker to pay more for a softened water than to soften it on his own premises? Does this apply to the domestic consumer, as well as to the industrial consumer? If you believe that centralized water softening is economically feasible, what softening process would you recommend and under what circumstances would you recommend an alternate process? Do you believe that with the lime and soda process there is considerable difficulty with sedimentation in the mains and service pipes leading to extensive repair bills, which offset the theoretical savings due to the process?"

Having no other end in view then the advancement of knowledge we invite all interested persons to present their views on the subject for publication in succeeding issues of this magazine.

We hope all will keep in mind the desirability of emphasizing the fact that where centralized softening is introduced in an old, established water works system, that water rates must be advanced to compensate the water department or company for the additional expense of furnishing a softened water to consumers. Of course, if the centralized softening of water is justifiable on economic grounds, the cost of household softening will be reduced so the consumer can afford to pay a higher water rate and save money by the change in procedure. Let us be careful to safeguard the economic rights of the utilities in this matter, making sure no injustice is done them.)

Mr. Frederic Bass, Professor of Civil Engineering in the University of Minnesota, writes:

"In general, it seems to me that, in cases where the water supply is very hard and where the number of consumers is large, it would be desirable to have a central softening plant, and that this would apply to the domestic consumer as well as the industrial consumer. I do not know just where to draw the line between the desirability of a central softening plant on one hand, and individual softening plants on the other, since the choice would depend upon so many local conditions, such as the size of the city, as well as the character and amount of hardness to be removed, and the possibility of some other source of water supply being substituted for the one in use. I think, without any doubt, there has been some sedimentation in mains from the use of central softening plants, but I have no data myself on the repair bills which may have been entailed as a result of the central softening plant."

Mr. E. B. Black, of Black & Veatch, Consulting Engineers, Mutual Bldg., Kansas City, Mo., writes:

"Just now Kansas City is engaged in her second fight for an $11,000,000 bond issue to allow the building of much needed water works improvements, which will include a softening and filtration plant for Missouri River water. Our Kansas City Engineers' Club is furnishing ammunition for the use of those actively campaigning for the bonds.

"To my mind the feasibility of economically softening an entire public water supply, prior to distribution, has been often demonstrated. Without doubt such a process will be more economical and more satisfactory when handled at one plant, than if the average water user attempts softening on his own premises. One plant has the advantage of skilled operation, and, therefore, a uniform water is supplied users. Only industrial users

requiring considerable quantities of water, can hope to operate so efficiently or so economically as one large plant.

"The average user will be well served if a water of 20 grains per gallon, is reduced to a hardness of between 5 and 6 grains per gallon. Such a reduction will ordinarily more than pay for the softening process by the saving in soap, plumbing, boilers and fuel, required by the "hard" water. This statement applies particularly to the average family. The saving to an industrial user cannot be approximated without an analysis of his water requirements.

"My opinion is that the "cold" or lime and soda ash process is the best and most economical method now known for softening large supplies. Analysis of a given water frequently shows it is unnecessary to remove more than "temporary" hardness, which is accomplished by the lime treatment alone. The proposed plant for Kansas City will make use of the lime only, reducing the hardness from about 22 grains to approximately 6 grains per gallon.

"In times past the difficulties experienced from deposits or sediment in mains and service pipes, have come about because of lack of adequate filtration for removal of sludge following the softening process. The number of plants following softening by filtration, and successfully eliminating this difficulty, show that there is no excuse for its occurrence if the filter plant is properly designed. My own firm has successfully eliminated this trouble in several municipal plants and other engineers have, of course, had the same gratifying experience."

Mr. Charles B. Burdick, of Alvord, Burdick & Howson, consulting hydraulic and sanitary engineers, Hartford Bldg., Chicago, writes:

"The Middle West is particularly a locality where the softening of the public supply warrants much more consideration than it has received up to the present time.

"Hardness is a relative term. Most waters in this region are relatively hard. The surface waters of the Middle West are relatively soft as compared to the ground waters, although even our surface waters would be considered hard on the Atlantic and Pacific coasts and elsewhere in the localities where granite bed rock lies close to the surface. A few of our surface supplies become excessively hard at certain periods of the year.

"Speaking broadly, it would pay and pay well to soften our public supplies where ground water is used. Healthfulness is probably not involved, but the benefits from reduced household expenses are more than sufficient to balance costs and in many localities the mineral character of the public water supply determines whether the development of the city shall or shall not be industrial. There are several midwestern cities whose growth has been so retarded that they have been passed by more fortunate neighbors, apparently due to an excessively hard public water supply such that it is improfitable for use by manufacturers.

"Up to the present time the lime and soda process is practically the only one available for the softening of the municipal supply. It has its defects such as the necessity for expert supervision if after deposits in the water mains are to be avoided. Its comparatively low cost commends it, however, even considering the disadvantages.

"There are other processes, much better adapted to smaller supplies, which are not as yet sufficiently low in cost to make them practicable in a municipal supply. In determining this practicability, the comparatively small cost of water in general must be reckoned with. Good water, of course, is worth whatever it costs. We must have it. We have become so accustomed, however, to getting it practically for nothing as compared to our other expenses that softening often appears to be an expensive process, although in many cases, as compared to benefits, the cost is very small."

Mr. J. N. Chester, of The J. N. Chester, Engineers, Union Bank Bldg., Pittsburgh, Pa., writes:

"I should never recommend or adopt a water supply that need be softened, if at a reasonable expense, or reasonable excess, a supply that did not need softening was available.

"This applies to the domestic consumer. Most water supplies would be better for industrial purposes if softened.

"If the domestic supply must be softened, then in my opinion a centralized water softening plant is economically feasible. I should hesitate to recommend a process until I knew the chemical makeup of the water to be softened.

"Accompanying the softening process, there is always trouble in the filters, and many times trouble in the mains and meters, from deposit."

Mr. Cornelius M. Daily, Engineer in charge, Supply and Purifying Section, St. Louis Water Works, 34 E. Grand Ave., St. Louis, Mo., writes:

"The problem of softening public water supplies at central points before distribution is undoubtedly cheaper for the domestic consumer or the industrial consumer, if the cost is borne by all the users in proportion to the quantity consumed by each.

"The human element entering into the selection of a standard for softened water will be so variable that the theoretical saving of soap and coal as calculated by chemists, will be liberally discounted and hard to use as a balance against the cost of softening the water. The necessary data, at the present time, are not obtainable for estimating the saving to a city by softening its water to any specific degree.

"The desire in any community for softer water than is obtainable from most of the western rivers, will grow as the difficulty of using hard water increases with the development of industries within the community.

"The total hardness, expressed as calcium carbonate in parts per million in the tap water of eight representative cities of the United States, using river water, is approximately as follows: Columbus, 106; Cincinnati, 102; Grand Rapids, 135; Harrisburg, 72; Minneapolis, 167; New Orleans, 67; Pittsburg, 71, and St. Louis, 106. The average hardness of the elght cities is 103 or about 75 more than the average hardness of the water used by New York.

"The cost of removing one part of hardness at the St. Louis water works in reducing the hardness from 189 to 106, was the cost of 1.15 parts of commercial lime plus 34% for labor, water, etc., amounting to $7.09 per million gallons for 83 parts of hardness removed, or 8.47 cts. per part of hardness. The non-carbonate hardness was increased from 46 parts to 52.

"In cold weather difficulty was encountered by clogging of hot water pipes in the city when the normal carbonates ($CaCo_3$) hardness exceeded about 30 which limited the amount of lime used in removing its bi-carbonate hardness. The addition of soda ash under these conditions would merely change the non-carbonate hardness to carbonate hardness without any reduction of the total.

"The allowable quantity of $CaCo_3$ remaining in the treated water is at the present time an arbitrary figure and a wide variation from 30 parts per million may in the light of more experience, be found desirable.

"It is unfortunate that cold water possesses properties of holding more calcium carbonate in solution than hot water, especially when small amounts of some of the sodium salts are present, which makes the softening with lime or soda ash or a combination of the chemicals more objectionable than if the properties were the reverse.

"In the heated water where CO_2 cannot escape from the bi-carbonates, they stay in solution and only the carbonates are deposited. However, for boiler purposes where higher temperatures are reached this is not true.

"The use of Permutit offers a solution of the problem at a cost not far in excess of lime and soda ash treatment, and without the objection of increasing the carbonates. For small industrial plants its use would be very satisfactory, and the cost not excessive for a relatively small quantity of water softened.

"Where it is necessary for the domestic consumers to have softer water than that furnished them, the problem of softening it at a central plant must be solved for each community which involves different standards and different peculiarities of the water to be treated.

"The purification of water is becoming a more complex manufacturing process and perhaps the day is not far in the future when lime kilns will be an adjunct to the purification plant, and both products of the kilns, lime and carbon dioxide, together with soda ash, be used to obtain a soft water from supplies now considered very hard. The softening will be limited only by the quantity of calcium carbonate held in solution and by the use of carbon dioxide the normal carbonate may be changed to the less objectionable bi-carbonate without necessarily injuring the distribution pipes.

"The success of a softening plant must depend upon frequent chemical analysis of both raw and treated water to insure that the proper amounts of chemicals are being added to the raw water, which in most rivers is constantly varying in quantities of mineral salts held in solution.

"The cost of softening any water to a definite degree can easily be estimated, but the value to the consumers cannot be expressed in dollars and cents with a degree of accuracy greater than the value of clean streets, well kept parks or public swimming pools, can be expressed by that standard of value."

Mr. Samuel A. Greeley, of Pearse, Greeley & Hansen, Consulting Hydraulic and Sanitary Engineers, 39 W. Adams St., Chicago, writes:

"The editor of Municipal and County Engineering has brought to my attention the matter of water softening and has asked for a brief statement relative to the feasibility of softening public water supplies at central stations. The editor includes the inquiry as to whether with present water softening processes using lime and soda there is considerable difficulty with sedimentation in the mains and service pipes. This is a very pertinent matter at the present time.

"In the past many water softening plants have been installed. The majority of these have been for industrial service in which long distribution systems are not generally common. The tendencies in such practice have been to install what may be termed stock apparatus. For a wide variety of waters the similarity of industrial softening plants is quite marked. This practice has had its influence on municipal installations. However, a number of first-class municipal installations are in operation in which the design of the plant has been based primarily on the needs of the particular

"Experience in operation is developing more and more the need for careful consideration of the peculiar qualities of each water supply to be treated. It has been found that waters are essentially unlike and the treatment must be adjusted to the particular characteristics of each water. At the present time this is primarily true as regards the conditioning of water prior to filtration. In iron removal plants, for instance, it has been found to increase the difficulties of operation if much of the iron is left in the water to be removed in the fine sand filters. The preliminary treatment of the water is thus assuming greater importance. This involves not only methods of applying chemicals, preliminary aeration of the water, the design of reaction and settling tanks and the like, but also to a closer operating control. The recently perfected apparatus for determining the hydrogen ion concentration of waters is offering a means for more closely controlling the application of alum and other chemicals. Recent advances in the knowledge of colloidal chemistry and the phenomenon of adsorption have further facilitated the operation of conditioning processes in water treatment plants. Coupled with this are improved mechanical means for handling rapid sand filters. All of this practical engineering development permits of greater assurances in predicting the results of water treatment.

"In view of the difference between waters and the importance of spending money for water treatment plants so as to produce the best return, a careful preliminary investigation should be made before proceeding with design. In some cases laboratory tests will be sufficient, but in other cases where the treatment is likely to be difficult, testing stations of greater or less size should be built. In our practice during the last 5 years we have found it desirable to build and operate 4 such small testing stations. In any event, a thorough knowledge of the water to be treated and its reaction to various treatment processes should be determined in advance of design.

"Hard waters are objectionable in many ways. For domestic use they require larger quantities of soap, they are unsatisfactory for washing, have an annoying effect on the skin and increase the plumbing bill. For boiler use they cause trouble by forming scale, cause interruption in service, shorten the life of boilers and fire boxes and increase the fuel bill. In certain industrial processes hard waters are considerably less satisfactory than soft waters. It is generally easy to make a computation on paper proving that water softening pays. It is frequently, however, found difficult to finance the first cost even at the assured annual saving.

"As the increase in population of cities tends to become slower and more settled the competition for new industrial establishments increases. It is believed that a study of city growth would indicate a general tendency for communities with soft waters to grow faster than communities with hard waters. Thus the installation of water softening plants will tend to community development. Furthermore as soft waters become more common, housekeepers learn of their advantage in moving from one city to another, and thus the demand for soft water increases.

"It appears, therefore, that water softening is on a satisfactory basis for design, construction and operation. It is not a process that can be applied generally to all waters along stock designs. Each installation should be designed to handle properly the water needing treatment."

Mr. Charles P. Hoover, chemist in charge, Water Softening and Purification Works, Columbus, Ohio, writes:

"Yes; I consider it economically feasible to soften an entire public water supply at a central point before it is distributed to the consumer, and furthermore

believe that it is cheaper and more satisfactory to the domestic and industrial water taker to pay more for water that has been softened than to use hard water or to attempt to soften the water which he uses.

"Lime is the most economical chemical known for removing the temporary hardness from water. Water having a hardness of less than 350 parts per million, made up of both temporary and permanent hardness, and it being desired to reduce the hardness to 85 parts per million (85 parts per million we believe to be satisfactory for a municipal water supply), then the Lime—Soda-ash process is the most economical process to use. For softening water having a hardness of more than 350 to 400 parts per million, a combination of the Lime-Soda-ash process with the Zeolite process might work out satisfactorily.

"Example: First, treat the water with sufficient lime and soda-ash to reduce the hardness to 120 parts per million.

"Second, reduce to zero hardness by the Zeolite process 30% of the lime-soda softened water.

"Third, mix the 70% of water having a hardness of 120 parts per million with the 30% of water having a zero hardness, and the resultant water should have a hardness of about 84 or 85 parts per million.

"The Zeolite softened water, containing bicarbonates, neutralizing the monocarbonates present in the lime-soda softened water, should produce a water that would be stable, thus eliminating troubles from incrustation of the sand grains and deposits in the service pipes and meters.

"Considerable work has been done and is being done at this plant on the neutralizing of normal carbonates in lime-soda softened water. and the results of this work will be published at a later date.

"I agree with you that the next great development in the water works art is destined to be in the centralized softening of water, but this development is being held back because of the trouble encountered with the incrustation of the sand beds through which the lime-soda softened water is filtered, and the deposits in the service pipes and meters. This, I believe, can be overcome in an economical, simple and practical way, and when it is finally worked out along these lines, the softening of hard water supplies will become more general."

Mr. J. W. Ledoux, Consulting Engineer, 112 N. Broad St., Philadelphia, Pa., writes:

"I am of the opinion that where the conditions are such that a public utility cannot obtain a reasonably soft water and where it would be necessary for all the industrial plants to treat the water for boiler use, that it is far better and cheaper for the utility to undertake that function.

"For such waters as the Great Lakes, containing 100 to 150 parts total solids, the public utility would not be warranted in softening the water, although many industrial plants consider it to their advantage to do so.

"In the southwestern part of the United States, where it is generally impossible to procure soft water, it is usual to consider that the water does not require public treatment unless it contains more than 25 grains per gallon, or say 400 parts per gallon, but even under these circumstances, all the industrial plants and railroads always find it advantageous to soften the water.

"I should say that it would be better for a utility to undertake the softening of the entire water supply when the hardness is over 250 parts per million composed of calcium carbonate and calcium sulphate.

"The advantage of soft water applies particularly to boiler and other hot water uses, but chemists have shown that the saving in soap for domestic and other purposes would pay a handsome return on the investment in the softening plant. Some eminent physicians are of the opinion that hard water for potable use is the cause of several common maladies, such as gallstones, stone in the bladder and goitre.

"Where the hardness is due principally to calcium carbonate, this is kept in suspension, by an excess of free carbonic acid, so to soften the water it is only necessary to add an excess of lime, which takes up the carbonic acid, precipitating the lime in solution. This is the well-known Clark process, but if a large portion of the hardness consists of calcium sulphate, lime is no longer effective, so it is necessary to use caustic soda, or carbonate of soda, the latter being the most practical and economical. Where the water contains a combination of these two ingredients, as it generally does, a lime and soda plant is necessary combined with sedimentation and filtration. In some cases where water has been thus treated difficulty has been experienced

due to subsequent lime precipitates, but this has been overcome by treating the water after sedimentation and prior to filtration with carbonic acid, it being better to have a small amount of lime in solution than to have it precipitate in the pipes and other receptacles.

"Carbonic acid may be produced from coke at the softening plant. A recent example of this process may be seen at Defiance, Ohio."

Mr. Gardner S. Williams, Consulting Engineer, Cornwell Bldg., Ann Arbor, Mich., writes:

"I agree with you that the centralized softening of water is one of the very important, if not the most important problem before Water Supply Engineers at the present time. I think there will be found no question but that the softening of water in a central station is preferable to the softening by the individual, both from the standpoint of cost and from that of results obtained. I think this statement would apply with more force in the case of domestic consumers perhaps than with industrial consumers.

"My limited observation has led me to believe that the processes to be used in water softening may very properly depend upon the content of the water, which is materially different in different localities. For that reason it does not seem possible to lay down in advance what would be the most desirable process."

WATER SOFTENING PROPOSED AT MINNEAPOLIS, MINN.

By Lewis I. Birdsall, Superintendent Purification Division, Water Works Department, Minneapolis, Minn.

The City of Minneapolis obtains its water supply from the Mississippi River. The water is purified by means of sedimentation, coagulation, filtration and sterilization. No attempt is made to soften the water at the present time, but plans have been proposed for a water softening plant to be built in connection with future enlargement of the water purification plant.

Hardness of Minneapolis Water

The Mississippi river water at Minneapolis varies in total hardness from a maximum of 220 parts per million during January and February to a minimum of 100 parts during the spring rise in April. The average hardness during the year is 172 parts per million.

The average alkalinity of the river water is 162 parts per million and the average suphate (SO4) content 7.1 parts. The Mississippi water at Minneapolis is a calcium and magnesium bicarbonate water, the calcium accounting for approximately two-thirds of the total hardness and the magnesium one-third.

Although the Minneapolis water is not classed as an extremely hard water, there has been constant agitation during the past 20 years for a water softening plant.

The necessity of enlarging the filtration plant in 1914-1915 and again in 1917-1918, delayed the water softening project through lack of funds.

Location of Water Softening Plant

The City of Minneapolis has acquired a tract of land, containing approximately 40 acres, situated on the east bank of the Mississippi river about one mile north of the city limits and three miles west of the present water purification plant. On this land will be built another water purification plant when required and also a water softening plant large enough to soften all of the city water supply.

The location of these future plants on the river bank rather than in the vicinity of the present filtration plant was due to several reasons. The large amount of sludge which results from water softening can be most easily disposed of by flushing it directly into the river. The softened water can be run by gravity to the suction wells of the present pumping station and from there be pumped to the present purification plant. The softened and purified water from the new filtration plant on the river bank can be pumped directly into the distribution system three miles nearer to the center of the city, using the present clear water reservoir as a standpipe.

Method of Softening

Lime will undoubtedly be used for softening the Minneapolis water. The low sulphate content will obviate the use of soda ash. The bicarbonates of calcium and magnesium can be removed by the use of lime only.

The degree of softening has not yet been definitely determined but it is probable that 100 parts per million of hardness will be left in the water the year through and only the hardness above this amount will be removed. A water with a hardness of 100 parts per million is not objectional to the people of Minneapolis and any person or industry that desires a safter water can arrange to soften the city water on his own premises to suit his own purposes.

Experimental Plant

An experimental softening plant with a capacity of approximately 40,000 gals. of water per day has already been built in the Camden pumping station. This plant will be operated for a period of one year in order to determine size of basins, best methods of mixing the lime with the water, rate of flow, and other data that will be required before the construction of a large softening plant can be undertaken.

Mr. J. A. Jensen, Supervisor of Water Works, Minneapolis, is in charge of the general plans for the water softening and new filtration plant projects.

A COMPARISON OF THE HARDNESS OF PUBLIC WATER SUPPLIES IN MASSACHUSETTS, NEW YORK AND NEW JERSEY

By Waldo S. Coulter, Consulting Engineer, 114 Liberty Street, New York City.

Pearmain and Moore, in their "Water Supply," offer the following classification of water as to hardness:

Very soft ..... 30 to 50 parts per million
Moderate ..... 50 to 100 parts per million
Hard .....100 to 300 parts per million
Very hard ....Above 300 parts per million

A greater hardness than 300 they consider undesirable from a hygienic standpoint.

Some thing like this classification is accepted by most water works engineers.

In practice, it is applicable only in a general way, however, as what would readily be accepted in some sections of the country as a soft water would be elsewhere regarded as intolerably hard. Prof. William P. Mason states this neatly in his "Examination of Water," as follows: "The rating of water as 'hard' or 'soft' is very often a matter of local preference. Thus the writer has encountered cases of complaint from people using a water of as low a hardness as 30 parts per million; and has heard described as of 'good quality for boiler and laundry uses,' a water which ran 66 in hardness. After wide inquiry among industrial water users the author has concluded to classify waters as 'soft' which do not exceed 50 in hardness; to call those 'hard' which exceed 100; and to consider the intermediate values as a sort of neutral ground where local conditions and preferences shall govern."

Massachusetts

The state of Massachusetts is, outside of the Connecticut valley, generally underlaid by impervious crystalline and metamorphic rocks. Over these is a heavy mantle of glacial drift, almost entirely derived from these rocks and so quite free from lime. Sub-surface supplies are generally taken from the drift above the consolidated formations, although good wells are secured in the Connecticut valley sandstone. Both surface and ground waters are exceptionally soft.

Table I shows the average hardness of water for 104 Massachusetts water supplies taken at random and fairly representative of the whole state.

TABLE I—HARDNESS OF WATER IN 104 MASSACHUSETTS WATER SUPPLIES.

Number of Systems Considered		Average Hardness in Parts per Million	
Surface	Ground	Surface	Ground
52	52	18.2	27.3

The average hardness of the ground water is 50% greater than that of the surface water, for the supplies covered by the summary in Table I. This is much less than the usual difference between ground and surface waters, and illustrates the comparative absence of lime and magnesium from the drift deposits.

New Jersey

The State of New Jersey presents somewhat different conditions. Only the northern part of the state is overlaid by glacial drift. The consolidated formations underlying this, and from which it is principally derived, are largely crystalline and metamorphic rocks and red shales and sandstone. The shale and sandstone formations are of Triassic age, the latter containing feldspar, which offers some elements for hardening sub-surface water.

TABLE II—ALKALINITY AND ASSUMED HARDNESS OF WATER IN 74 NEW JERSEY WATER SUPPLIES.

Character of Formation	Number of Systems Considered		Average Alkalinity in Parts per Million (Hardness in parentheses)			
	Surface	Ground	Surface		Ground	
Coastal Plain (clay, sand, gravel, etc., of Cretaceous, Tertiary and Quarternary age)	6	31	13.0	(16.0)	42.7	(52.5)
Triassic (sandstone and shales)	9	8	43.2	(53.1)	80.8	(99.4)
Highland Region (gneisses, schists, etc.)	10	10	20.1	(24.7)	58.5	(72.0)
Entire state	25	49	26.7	(32.8)	52.1	(64.1)

TABLE III—HARDNESS OF WATER IN 111 NEW YORK STATE WATER SUPPLIES

Character of Formation	Number of Systems Considered Surface	Ground	Average Hardness in Parts per Million Surface Total Hardness	Surface Alkalinity	Ground Total Hardness	Ground Alkalinity
Triassic (sandstone)	0	0	....	....	....	....
Devonian (limestone, shales and sandstones)	26	24	64.8	53.0	158.5	122.3
Silurian (sandstones, limestones and shales)	10	5	75.1	62.8	243.0	150.8
Ordovician (limestones and shales)	15	14	86.6	78.1	148.0	134.8
Cambrian (sandstones and shales	2	2	22.1	16.5	74.5	66.5
Pre-Cambrian (crystalline rocks)	10	3	27.2	18.2	63.1	56.3
Entire state	63	48	64.3	53.9	155.0	122.5

A comparison of the state averages may now be made as follows:

HARDNESS OF WATER.

Comparison of Averages for the States of Massachusetts, New Jersey and New York.

State	Number of Supplies Considered Surface	Ground	Hardness Surface	Ground
Massachusetts	52	52	18.2	27.3
New Jersey	25	49	32.8*	64.1*
New York	63	48	64.3	155.0

*Approximation derived from alkalinity.

South of the drift lies the coastal plain, consisting of unconsolidated materials, many of them of Cretaceous age and leached quite free from hardening salts.

Table II shows the average *alkalinity* of the water supplies of 74 well distributed communities fairly representative of the state. The figures for hardness are not given in the state reports from which this table is compiled, though they are on file at Trenton. As a very rough indicator of hardness, I have multiplied the alkalinity by the conversion factor 1.23. The hardness so secured follows the alkalinity in parentheses in the table.

It will be noted that the average hardness of these New Jersey waters is something less than twice that of the Massachusetts surface waters, and over twice that of the ground waters.

New York

For a further comparison, the State of New York may be taken. More than half the area of this state is underlaid by Devonian, Silurian and Ordovician formations containing large percentages of limestone. The entire state is covered by a blanket of glacial drift, in some places 300 ft. or more in thickness, usually of the same character as the underlying consolidated formations in the same general vicinity. Much of this drift therefore, contains abraded limestone. As a result, both surface and ground waters are hard in extensive portions of the state.

In addition to the rock formations mentioned, there are large areas of Cambrian sandstones and shales, and Pre-Cambrian crystalline rocks, which are comparatively free from hardening elements.

Table III shows the average hardness and alkalinity of 111 water supplies of the state, taken at random and approximately indicative of the state as a whole.

It will be noted that New Jersey stands, roughly, midway between Massachusetts and New York.

Conditions in the Middle West

In the middle west, conditions are in many places more conducive to hardness than those of New York. The following list, giving the hardness of the public supplies of several large cities in that section, may be compared with what has already been stated.

City	Hardness in Parts per Million.
Indianapolis	300
Kansas City	230
Omaha	230
Toledo	224
Columbus	279—Raw (After softening=100)
Grand Rapids	249—Raw (After softening=100)
St. Louis	190—Raw (After softening=102)

In Massachusetts, the water of Reading in 1916, after treatment to remove iron, had a hardness of about 100. This was there looked upon as an exceedingly hard water, but most of New York would not think so, and in the middle west such a water would be very welcome in many places.

Waters which in certain sections would be rated "soft," would seem to one from

FORTY-THREE years ago Alexander Graham Bell, the inventor of the telephone, wrote this inspired forecast: "It is conceivable that cables of telephone wires could be laid underground or suspended overhead, communicating by branch wires with private dwellings, country houses, shops, manufacturers, etc., and a man in one part of the country may communicate by word of mouth with another in a distant place."

At the right, an old print of Bell lecturing on telephony, 1877.

Foresight

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The foresight of the early pioneers has been developed into a science during the years which have elapsed, so that the planning of future operations has become a function of the Bell System. This is why the people of the United States have the most efficient and most economical telephone service in the world.

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Massachusetts to require softening. Yet any such suggestion, emanating from an engineer, might arouse in a western mind doubt as to whether such a man were practical.

So there you are. That acceptable standards can be established on a basis of economics there is no question; that consumers and taxpayers will everywhere recognize the validity of the standard is "something else again," as Mr. Perlmutter would say.

SOME PROBLEMS IN WATER WORKS CONSTRUCTION

By M. V. Norris, Vice President, Currie Engineering Co., Municipal Engineers, Webster City, Iowa.

When collecting designing data for the reconstruction or extension of a water works system, one of the first things we usually find is that the past records are either lost or have been very poorly kept. Oftentimes we cannot even find a map which shows the location and size of the mains, or the location of gate valves and hydrants. It is not a difficult task to locate all hydrants, for they can be seen by simply walking over the town. But it is very important that the records be properly kept, especially with respect to underground installations.

The best remedy for this phase of the evils of the past is for the Town or City to have a very carefully prepared water works atlas, showing the date of installation of all parts of the water works system, the size and location of all water mains, the exact location and size of all gate valves, the location of all fire hydrants, and plans for future extensions of the system as far as possible.

After a lengthy investigation, it is possible to make up a plat showing the location of existing mains, valves and hydrants and almost without exception, the existing distribution system has been built with no thought toward future construction or future growth of the town. It is common to find the main feeder pipe only 6 ins. in diameter when it should have been 8 ins., in order to give proper fire protection. It is also found in a great many cases that the distribution system has no circulation; that is, all mains have dead ends. This type of construction not only gives less efficient fire protection, but also does not deliver the water in its best state for domestic service.

The only remedy to offer for this situation is to design a system of reconstruction or extension which will give the proper results, both for the present needs and the future growth of the town. It is often difficult to show the town or city officials why it is necessary to replace a 4-in. pipe with a 6-in. pipe or to specify a block of 4-in. pipe as a circulating line, or to run a booster main to some particular corner of town where the fire protection has been very poor, due to lack of pressure. The mains, wherever possible and consistent with good business, should be run on streets that will serve the maximum number of people, since one of the best reasons for building a water works system is to deliver good fresh water to the people of the town for domestic purposes. The sale of water for domestic and manufacturing purposes will go a long way toward paying for the operation and upkeep of the water works system.

Since it is the duty of every town to deliver to its inhabitants the best quality of water available, the subject of water supply requires a great amount of thought and study. The problem must be investigated from the standpoint of quantity, quality, cost at the source and the cost to pump from the source to the consumer.

Too often in the past, towns and cities have not given careful thought to the most efficient and economical source of water supply. There are towns that have spent large sums of money for a satisfactory deep well water supply, when good shallow well supplies are more economically available. There are also towns that have spent large sums of money for unsatisfactory deep well water supply with excellent surface supplies at their door which need only filtration to produce an ideal water from the standpoint of quantity, quality, and cost at the consumers' meter.

On the other hand, towns are found using open wall shallow wells, surrounded by dangerous sources of pollution, when very good and safe deep well water is available.

Another problem that the engineer is often asked to solve, is the reason for excessive pumping costs. After this question has been studied, it is frequently found that the cost of pumping, based on the cost per gallon pumped, is not excessive, but the same total cost based on the cost per gallon consumed or sold is quite excessive. The first thing the engineer wants to know is the "amount of waste in the system." The most satisfactory method of keeping a check on this phase of the operation is to "meter" all water pumped as well as all water sold. In the case of water used for fire, of course, it

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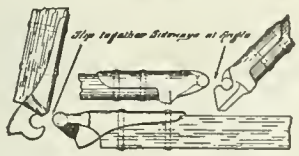

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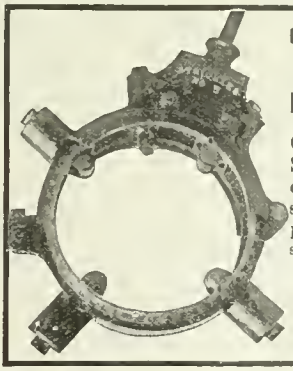

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would be difficult to determine the amount, but the ordinary consumption should check very closely with the amount pumped.

After making a careful study of the problems encountered in connection with the design and construction, redesign and reconstruction or the operation of a public water works system, it is only safe to say that each case is a problem by itself and depends in a large measure upon the facts which will be enconntered.

OWNERSHIP OF ONE "PRIVATE" WATER COMPANY

An example to prove the truth of the statement that "public utilities are the people's business" is to be found in the ownership of the Terre Haute Water Works Company, according to Dow R. Gwinn, president of the company. Mr. Gwinn announced recently that although the company's operations are confined to Terre Haute and vicinity, people living in 52 cities and towns of Indiana own first mortgage bonds on the company's property. More than that, people living in 90 cities and towns in Indiana own preferred stock.

He said: "Only a few years ago when a large block of securities came out dealers looked to New England to absorb the greater part. All the rest of the country absorbed but a small portion. Now, many companies are able to market not only the greater share, but many times the entire issue, with the people of their community or state, so greatly has the buying power been developed by calling in the small investor. Experts say the middle west is taking about one-quarter of all major issues sent into the market. The movement toward democracy in investment has had another illustration among public service corporations.

"Our company may be cited as an example of this movement. Some of our customers own stocks and bonds in the company. Practically all of the people owning an interest in our business are near enough to us to keep in close touch with us, and to come in and look over the property whenever they wish. This fact makes for better operation and far better relations between the company and its patrons.

"There are 19 stockholders who own all the common stock. But before they can make any profit or realize on their investment, we must pay interest to 296 holders of preferred stock, only 12 of whom live outside the state of Indiana. By far the greater number, 284, are scattered throughout Indiana, living in 90 different cities and towns. Besides paying interest to these holders of preferred stock, we must pay interest on $477,000 worth of first mortgage bonds, the owners of which live in 52 cities and towns of the state.

"I mention our own company to show how true is the statement that 'public utilities are the people's business.' The people are investing in public utilities, thus making it possible to extend the service to meet the growing demand and at the same time getting a safe and satisfactory investment. Our company is only one of hundreds of companies in the state of Indiana. Counting the individual owners of public utility stocks and bonds, and people who have bank deposits and life insurance policies, it would seem to be fairly evident that nearly every man and woman in Indiana is in some way concerned with the prosperity of the public utility industry."

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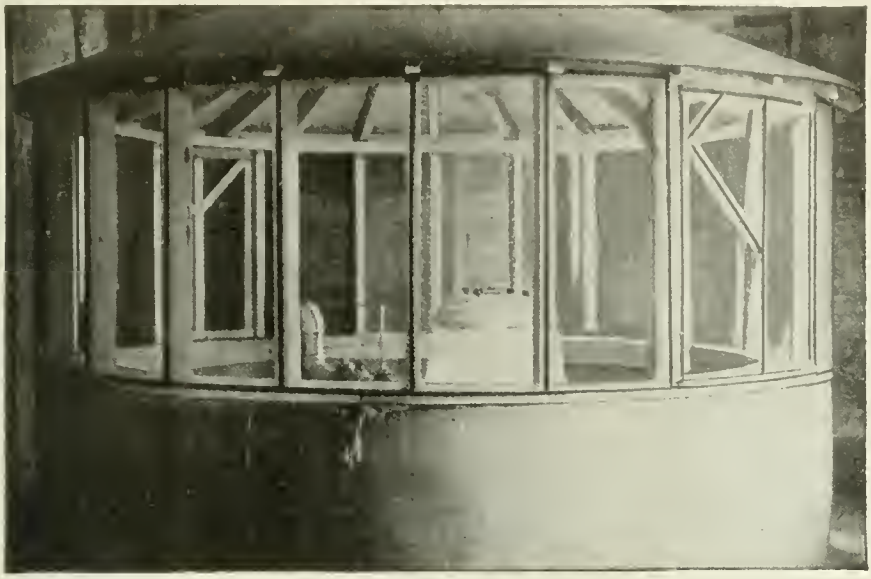

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Construction News and Equipment

HOW TRAVIS COUNTY, TEXAS REDUCED ROAD BUILDING COSTS

Travis County, Texas, is divided into four commissioners' precincts, each having a commissioner elected by the people of that precinct. Each commissioner is an ex-officio road superintendent of his precinct, and has direct charge of all roads and all road equipment for his precinct, and is in direct and actual supervision of such equipment in building, repairing or maintaining all of the roads.

The records show that on the first of September, 1920, the county had road equipment for the four commissioners' precincts aggregating in value approximately $28,000. This equipment was represented by mule teams, graders and scrapers, there being approximately eight or ten teams to each commissioner's precinct. On the first of September, 1921, the inventory for the county showed that the road equipment totaled $45,000. This increase in the value of the road equipment within the year was caused by the purchase early in the year of about $17,000 worth of tractors and graders, each of the three commissioners having purchased a 5-ton "Caterpillar" tractor for use on the roads, together with the necessary grading machinery. After having used the three 5-ton "Caterpillar" tractors for about eight months, the Commissioners' Court purchased additional equipment to the extent of three 10-ton tractors and one 5-ton tractor, together with the necessary grading machinery, making the total value of the road equipment on Oct. 1, 1921, $75,000.

For the purpose of showing the savings gained over team-drawn outfits in Travis County, the operation of the 10-ton "Caterpillar" tractor in Mr. Brodie's precinct affords a fair example. The records show that Mr. Brodie had operated his mule-team outfit, consisting of 5 teams, grading equipment and 8 men, for the first 9 months in the year, at a cost of $5,956.81, and during those 9 months had constructed 31 miles of road, at a cost of approximately $200 a mile.

The records show that for the two months that the 10-ton "Caterpillar" tractor has been at work on the roads in his precinct he has constructed 25 miles at a cost of $1,170, or $46.80 per mile, this $1,170 taking into consideration the wages of two men, one operating the tractor and one operating the grader, all expenses for ordinary wear and tear on the grader (there being no repairs whatever on the tractor), and all interest and depreciation charges on both machines.

Roads built by the mule teams and by the tractor were in all respects alike as far as condition of soil and hills were concerned, the roads upon which each of them worked running west from Austin to the county line and being of adobe and limestone formation, with many boulders both in the ditches and in the surface of the road. The mule team outfit built only a 20-ft. road from ditch to ditch, while the tractor in its work built a roadway that would approximate 35 ft. from ditch to ditch. Needless to say that Mr. Brodie, who, up until the time the tractor was put to work in his precinct, was not entirely satisfied that it could successfully work on those roads, was finally convinced that the "Caterpillar" tractor could not be surpassed for road work in his precinct, and he and his constituents look forward to an early completion of a system of well-drained, well-graded highways at a minimum cost.

Back in the days when they used all mules in Precinct No. 1, it took Commissioner Giles 9 weeks, with 14 head of mules, to grade to a turnpike 6 miles of road. With one 10-ton "Caterpillar" tractor and one grader operator he put up the same 6 miles in 6 days. Commissioner Holman, of Precinct No. 2, says: "I think the use of motorized road-building outfits is a good business proposition. For the same money you can build three times as much road as with mules." In Precinct No. 4 Commissioner Williamson reports that his 5-ton "Caterpillar," pulling a grader, does more work in an average day than 20 mules with 2 graders and 2 plows.

GASOLINE SHOVEL IN DANGEROUS MOUNTAIN ROAD WORK

The accompanying illustration of the Bear Creek Road job shows an interesting application of a Pawling & Harnischfeger gasoline-driven power shovel used by the contractor, C. Miles. The road work, 3000 ft. above sea level in the Santa Cruz Mountains, was done at a figure 30 cts. per cu. yd. less than estimated by experienced excavating contractors and illustrates that the freedom of movement of a gasoline-driven shovel is an important factor. The work was done by excavating one side of

P & H GASOLINE SHOVEL ON MOUNTAIN ROAD GRADING.

the road and over-casting to form the other half. Because of requiring no water pipe line to the shovel, it may be operated in remote locations far away from source of supplies. The gasoline fuel used in comparatively small amount is easier to supply than coal, wood or crude oil. The corduroy traction gives the mobility needed to operate continuously, one man on the shovel having all movements of the bucket and machine under his control. The services of licensed engineer and firemen are not required.

A NEW GASOLINE REVOLVING SHOVEL

A gasoline operated shovel with no engines, motors, shafts, chains or gears on the boom and yet with an actual digging power greater than a steam shovel of the same size is the most recent innovation in the manufacture of excavating machinery. Such a shovel has recently been announced by the Bucyrus Company of South Milwaukee, Wisconsin.

This machine, which is known as their 30-B gasoline shovel, marks an advance in the design of excavating machinery. For more than ten years Bucyrus dragline excavators have been operated by gasoline engines, but the application of this power to the revolving shovel involved more difficult and intricate problems, chief among these being the efficient transmission of power to the thrust without excessive complications in design, and the obtaining of digging power commensurate with that of a steam machine of similar size.

Both of these problems have been satisfactorily solved in this new shovel, it is claimed. Furthermore, the manufacturers have succeeded in obtaining in this new machine the digging characteristics of the steam shovel with its quick reversals, its powerful thrust of the dipper and its dependability.

Before being put on the market, this shovel was used for a period of six months for overcasting and loading dump cars in sticky clay, for grading for a concrete road where the cut averaged 5 ins. in old macadam, and for stripping a stone quarry and loading trucks in a stiff harpan containing many boulders. Its success, therefore, has been completely demonstrated by actual test in the field.

NEW BUCYRUS GASOLINE SHOVEL DIGGING THROUGH 5 INS. OF OLD TAR MACADAM ON HIGHWAY WORK.

The outstanding features of this shovel may be summarized as follows:

The gasoline engine with which this shovel is equipped is over twice as heavy and rugged as the type of commercial gasoline engine sold for this purpose. It was designed especially for this shovel from specifications offered by the Bucyrus engineers and consequently it is

suited for the exacting requirements of this unusually severe service.

It is entirely inclosed and thus dustproof, a feature of much importance for excavating work. The engine is a 4-cylinder, slow speed type and will develop 55 h. p. at a speed of 400 R. P. M. The shovel carries a 1-yd. dipper. This machine may be equipped as a dragline excavator, a crane or a clamshell machine with simple changes which may be made in the field.

The 30-B gasoline shovel fills a want for those whose work is in arid regions or where coal is scarce and expensive and feed water of poor character.

COST KEEPING ON HIGHWAY CONSTRUCTION

By A. R. Losh, Assistant Chief of Construction, U. S. Bureau of Public Roads, Washington, D. C.

From an extensive investigation made about 6 years ago by the Bureau of Public Roads it was found that generally very little cost keeping was done by state and county highway departments on highway work. There was at that time very little interest manifested by public officials in cost keeping on highway work.

A similar condition with respect to cost keeping existed to a large extent among road contractors. At this time there had been a long period of almost uniform conditions with respect to labor, materials, types of construction, and processes. The successful contractor had grown up in the business and had rules and methods of his own for estimating, which were based on years of experience and he did not feel the need of cost statistics. The greater portion of the highway work of the time was done by the type of contractor referred to as having his hat for his office and his check-book for his cost record of the job. The more substantial contracting organizations and especially those which did not confine their operations to road work exclusively carried cost keeping records on their road work. As a rule highway engineers attempted to obtain the costs on contract work but generally did not give sufficient attention to the details of cost keeping to obtain complete and reliable data.

Day Labor Work Determines Costs

It has developed from a recent preliminary study of highway cost keeping conditions that there has been a substantial improvement since the investigations previously referred to were made. Of recent years, due to a scarcity of contractors in the highway field, it has been necessary for states and counties to do a large amount of highway work with day labor forces and the value of cost keeping as a check on expenitures and as a guide to efficient management has led to the installation of cost keeping of some kind on this work. In addition to serving these ends many valuable cost data have been accumulated which form an important part of the fiscal records of the work and have also been used advantageously in placing other work under contract. The advantages of keeping cost on day labor work are generally recognized but there are divergent views with respect to keeping costs on contract work. As a result it will be found that with one state highway department cost keeping on contract work is incidental to the inspection and the resident engineer or inspector is to considerable extent left to his own devices in this regard, while with another state highway department the cost keeping is one of the important functions of the residency and not considered a sideline by any means.

Cost Keeping Valueless Unless Properly Carried On

When the cost on contract work is considered advantageously the method followed is either to select the jobs which will supply the information desired or to cover the entire program and keep costs on all contracts. In either case there should be sufficient force available to handle the inspection and cost keeping properly. It will be difficult if not impossible to secure satisfactory results unless the inspectors or cost-keepers receive specific instructions as to what they are to do, are supplied with standard recording and report forms, and their cost keeping supervised as well as their inspection work. It is not meant to infer that cost keeping is of the same importance as the inspection of the construction, but that if cost keeping is to be carried on at all it should have more than casual attention from the administrative authorities.

Advantages of Cost Keeping on Contract Work

The advantages resulting from keeping costs on contract work are usually given as follows:

1. Valuable cost data are secured which may be used for estimating purposes.

2. The department has available necessary cost data for making settlement

with contractor where unforeseen conditions are involved.

3. Engineers and inspectors receive training in use of cost data and making up of estimates.

4. Provides a means for analyzing cost of work which may lead to development of more economical designs and methods.

5. In some cases of assistance to the contractor who may not have an adequate cost system.

The Bureau of Public Roads has abandoned the practice of keeping costs on all of its contract jobs but is instead keeping costs on all day labor work and on such contracts where it is thought the data will be advantageous to the Bureau. It will prove advantageous to a state highway department to collect cost data on a number of representative contracts each year as a general check on the cost of its designs and also to determine the margin of profit contractors are getting.

Cost Keeping on the Increase Among Contractors

The increasing use of cost keeping by contractors is even more pronounced than in the case of the state and county organizations. This is due principally to the unsettled conditions during the past three years which have made estimating more difficult and rendered practically useless many cost data and hypothetical rules used a few years ago. New construction methods, and especially those processes requiring a more extensive use of equipment have also increased the need of cost keeping. Possibly the increasing number of engineers in the contracting field has had some effect in turning contractors to cost keeping. I twill be feund that highway contractors are now working individually and through their organizations for more systematic and businesslike methods in estimating work and in the keeping of construction costs. While no uniform method for keeping highway costs has as yet been suggested by contractors' organizations, practically all contractors are now keeping costs on their work. Some of the systems used are almost of the check book class in simplicity but they vary from this to a codified system of accounts divided and subdivided to collect cost of labor, materials, equipment and supervision on various operations. It appears that the present tendency is for highway contractors to develop cost keeping systems comparable with those in use by the building industry.

Primary Purpose of Cost Keeping

The primary purpose of cost keeping is to ascertain the actual cost of production. Not what the cost should be but what it is. For a contractor's use the cost system should furnish reliable data on current costs. In this way a periodic check on the cost of the work, which is an indication of the efficiency of the organization, is available as a managerial aid to the contractor or his superintendent. This function of a cost system is of especial value on highway work where there are usually a number of operations under way simultaneously on different parts of the job and in consequence all of the workmen are not continuously under the observation of the superintendent. Next in importance to the contractor is the value of cost data as a guide for estimating future work. The increasing complexity of highway construction is making cost keeping of more importance. The large sums of money now involved in road contracts mean more items of work, new processes, and additional operations over former requirements. To estimate the cost involved without comparable cost data is becoming too costly a hazard. It is not enough to know that there was a net profit on the job, but in order to use the data for estimating purposes it must be known by items and operations the actual cost of production.

In the construction industry it is not practicable to determine unit costs with the provision and refinement that obtains in the manufacturing industry. This is due to the variable nature of the construction product and the frequent change of conditions. Also, since conditions are not identical on any two jobs cost data from one is only an approximate comparison for another. For these reasons cost data must be used as a guide or measure in forecasting future costs. Cost data on new or unusual methods of construction and on the use of various plant units are of particular value as similar conditions are likely to be encountered in the future and a basis for cost estimates is available.

The Proper Basis for a Cost System

It is believed that the proper basis for a cost system is the four principal elements of cost allocated to the units of production: (a) Labor Costs; (b) Material Costs; (c) Equipment Costs, and (d) Administration Cost or General Expenses.

The products of highway construction to which these cost elements are assignable are road parts. Fundamentally these parts are: (a) The right-of-way; (b)

The roadside, shoulders, and grade; (c) The traveled way or roadway proper; (d) Drainage channels or ditches and drains; (e) Drainage structures or bridges and culverts, and (f) Supplementary structures or miscellaneous road parts, such as guard rails, retaining walls, guide posts, etc.

Thus, there are 6 major products on each of which there may be 4 elements of expense or cost, consequently, we have 24 cost divisions. Since general expense is not ordinarily ascertained directly on production but is pro rated to the various operations the actual cost divisions with which the cost keeper is directly concerned are reduced to 18. It is believed that this is the minimum number of cost divisions which will provide a satisfactory highway cost-keeping system. These cost divisions are susceptible of much further analysis by breaking them up into various operations. For example, a square yard of concrete roadway is one of the unit products. The cost divisions for this are 3, i. e., labor, materials, and equipment. To these three may be added the pro rata general expense. For further analysis, this square yard of roadway may be subdivided into subgrade finishing, placing of forms, hauling materials, mixing concrete, placing concrete, curing concrete, etc. This illustrates how the system may be expanded to meet the requirements of any desired analysis.

In placing the cost items against the appropriate construction items the greatest difficulty appears to be in connection with "equipment costs" and "administration costs." It is the experience of the Bureau of Public Roads on its own work that these items are given less attention in the preparation of estimates and in the segregation of cost to construction items than the more nearly definite items of "labor" and "materials."

The Equipment Rental Factor

The handling of equipment costs has been greatly simplified by the use of a rental factor computed to cover fixed charges, depreciation, overhauling, lost time, storage, and supervision. In the case of its own plant the Bureau has prepared rental schedules for all units of equipment having a useful life of more than one working season and costing more than $25. Small tools and those which are usually worn out on one job are handled the same as materials. This plan has been in operation 3 years and except for a change from a monthly to a daily basis it is practically the same as originally developed. It has proven satisfactory on both day labor and contract work of the Bureau. A rental factor of this kind is necessary where current costs are determined for purposes of management. If greater accuracy is desirable for fiscal purposes an annual appraisal of the equipment may be made and the depreciation, repair, storage and other charges pro rated to the projects which have used the equipment.

General Expense

As general expense is not unusually assignable directly to units of construction and many of the expenditures do not come to the attention of the cost keeper on the job there is a tendency to overlook this element until the project nears completion, at which time the cost is pro rated to the work completed. The result is a sudden jump in unit costs. Even with this apparent defect this may prove the best method to adopt as it greatly simplifies the handling of general expense items. Where limited funds require careful attention to gross expenditure on a project this method is not recommended. Occasionally it is found that the general expense is quite high in starting a job and if this is pro rated to the small accomplishment during the first few weeks of the work there are shown abnormally high unit costs which are not a true indication of conditions.

Two suggestions are offered for the handling of general expense. First, it will be found advantageous to divide general expense into two parts, one of which includes those costs which are assignable directly to the project and the other the general administration costs of the organization which must be pro rated to all its various projects. This latter part need not be considered in current cost reports as it does not in any way affect the efficiency of the construction organization on the project. This part of the general expense may be apportioned to the project upon its completion. The second suggestion is that the amount of general expense (project) taken up and pro rated on current reports be a percentage of the total probable general expense, which percentage to be not greater than the percentage of the project completed. For example, if the project is only 10 per cent complete, pro rate to completed work not more than 10 per cent of the total probable general expense. On projects where the cost of "moving in," "camp installation," "organizing," and "disorganizing,"

is of a considerable amount the unit construction costs are likely to be materially affected if this entire cost is distributed before the work is well under way.

Fundamental Principles

A cost-keeping system to be successful must be based on certain fundamental principles. First of all it must be designed to furnish the particular information sought. This feature can not be too strongly emphasized as not infrequently much more time is spent in perfecting quasi-scientific forms, codes, and procedure than is given to working out a system for getting at the cost of doing work. The system devised must be reliable and accurate to a practical extent. Insofar as field procedure is concerned simplicity is a very important consideration and it should be such that the required data can be successfully compiled by foremen and timekeepers. The effectiveness of the system will depend to a great extent on the celerity with which the unit costs may be ascertained. Unless the cost of doing the work can be determined easily and promptly its value as an aid to efficient management is lost. Some consideration should be given to making the cost system adaptable to the general work of the organization and not design it entirely for an individual job or set of conditions. It requires time and considerable patience to get a system in working order and frequent changes in forms and instructions should be avoided as they are generally disconcerting to the men in charge of construction work. It must be understood that cost keeping ties in the general bookkeeping scheme of the organization and is not to be operated independent of the regular accounting. While the cost-keeper and bookkeeper make different use of the information, the basic data used should be the same.

The Cost of Cost Keeping

One of the reasons cost keeping has not received more encouragement in the past from engineers and contractors has been the question of its cost. A system laid out along the lines indicated and designed to give the information needed for the proper supervision or administration of the work of an organization need not be expensive considering the volume of business it handles. It is when a system is developed beyond the requirements of the organization that cost becomes an important consideration.

Highway Cost Keeping in Formative Stage

A review of the present status of cost keeping on highway work indicates that it is still very much in a formative stage. There are some excellent systems in operation in many of the state highway departments and among the larger contracting organizations, but on the larger part of the extensive highway program cost keeping as practiced leaves much to be desired. A great step forward would be accomplished by a general classification of cost-keeping terms. Many of these as now used are subject to several interpretations. Engineers and accountants could materially improve the situation by reaching a common understanding in this regard.

As an indication of the present interest in highway cost-keeping it is interesting to note that since the publication by the Bureau of Public Roads of its Cost Keeping Bulletin more than 5,000 copies have been distributed.

The foregoing paper by Mr. Losh was presented at the 1922 convention of the American Road Builders' Association.

NOTICE TO CONTRACTORS.
INDIANA STATE HIGHWAY COMMISSION

Indianapolis, Ind.

On April 3, 1922, at 2:00 P. M., the Indiana State Highway Commission will receive sealed bids on furnishing gravel and stone along the Ohio River and points adjacent thereto, as follows:

Aurora; Brooksburg; Rockport; Tell City; Hazelton; Cunningham Ferry; Evansville; West Franklin; Mt. Vernon; New Harmony; Jasper; Garvin Siding; Owensville; Poseyville; Princeton; Kings Station; Haubstadt; Stacer; Inglefield; Patoka; Douglas; Winslow; Oakland City and Petersburg.

Total quantity is approximately 117,000 tons.

Bidding blanks and specifications are on file in the office of the Indiana State Highway Commission, Indianapolis, Ind., where same may be obtained.

Contract will be let to the lowest and best bidder, but the right is reserved to reject any and all bids if cause exists therefor.

LAWRENCE E. LYONS,
Director.

Contracts Awarded

ROADS AND STREETS.

Ala., Anniston—J. F. Morgan Paving Co., Birmingham, Ala., awarded contract to pave 11 blks. (Bitulithic) at $80,000.

Ark., Mena—Western Construction Co., Box 232, 311 Reigler Bldg., Little Rock, awarded contract for constructing about 15 miles hard surfaced road and steel bridges from Mena to Okla. line, at $165,000.

Cal., Newman—Warren Constr. Co., Rialto Bldg., San Francis Co., awarded contract for paving streets in about 20 blocks in residence districts, at $144,635.

Cal., Sacramento—Warren Constr. Co., Portland, Ore., awarded contract for grading 6.9 mi. state hwy. in Santa Barbara Co. betw. Cuyama River and Buckhorn Crk., at $153,256.

Cal., Sacramento—F. Rolandi, 550 Montgomery St., San Francisco, awarded contract for grading 5.7 mi. state hwy. Mariposa Co., betw. Sierra Natl. forest and Briceburg, at $177,484.

Colo., Ft. Collins—R. V. Stryker, Denver, awarded contract for paving Mountain Ave., paving district, at $127,504. Paving involves 16 items, principal of which is the $50,000 cu. yds. of paving, with grading, parking, curbing, oak headers and removal of present gutters and cross-walks.

Fla., Lake Wales—Stidham & Hughes, Lakeland, Fla., awarded contr. to constr. 187,700 sq. yds. sheet asph. paving on stone foundation and brick on stone found., at $450,000.

Fla., Macclenny—State Rd. Dept. let contract to B. A. Inglis, Birmingham, Ala., and C. F. Lytle, Sioux City, Ia., to construct rd. from Columbia Co. line thru Baker, Nassau and Duval Cos., to Jacksonville, Projects 11, 21, 22 and 23—42.78 miles, at cost of $1,000,000.

Fla., Sebring—McDonald Constr. Co., Lakeland, awarded contr. for grading, paving and curbing 4 miles Mango, Lemon, Eucalyptus, Pomegranate, Poinsetta and Ridgewood Sts., at $113,310.

Fla., W. Palm Beach—G. Reynolds & Monroe,

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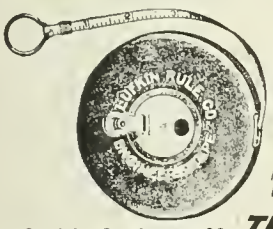

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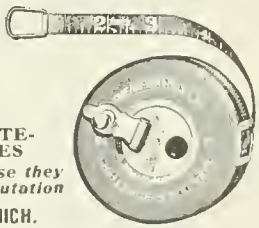

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awarded contract to construct 7 miles Lake Worth military road No. 10; Ojus rock 9-in. thick; 7 culvts. and brdg. 75-ft. long, at $65,569.

Ida., Boise—Lingo & Sarrow, Grangeville, awarded contract to build 3.5 miles hwy. in Cottonwood Hwy. Dist., Idaho Co. at $22,063; Triangle Constr. Co., Ritzville, Wn., awarded contract to construct 5.11 mi. hwy. Central Hwy. district, Lewis Co. at $44,541.

Ill., Cairo—Cameron, Joyce Co., Keokuk, Ia., awarded contract by Alexander Co. for novaculite, gravel paving, State Aid Route 2, Sec. 3-15-D, State Aid Routes 2 & 3, Sec. F-15-D, State Aid Route 3, Sec. G-15-D, State Aid Route 3, Sec. H-15-D, State Aid Route 3, Sec. 8-15-D, at $300,000.

Ia., Clarinda—J. S. McLaughlin & Sons, Mankato, Minn., awarded contract for paving various streets, also curbing and guttering at $161,000.

Ind., Mt. Vernon—Louis W. Raben and Lawrence Thomas, Mt. Vernon, awarded contract for constr. of 13 miles improved roads in Orange Co., at approx. $9,000 per mile.

Ind., Richmond—Downer & Mero, Richmond, awarded contract for constructing 7 miles of hwy. at $185,860.

Ill., Beardstown—J. D. McCarthy, Beardstown, awarded contract for paving various streets with vitr. brk. and asph. on conc. at $138,000.

La., New Iberia—Jones & Burke, awarded contract to constr. 12 mi. gravel roads, at $75,000; Iberia Parish, 6th Ward.

Mich., Grand Rapids—Following contracts for paving with concrete, awarded by City Commission: College Ave.—Dickinson to Griggs Streets—at $6,237; W. Butler St., 743 sq. yds., to Vander Weele Bros., $3,159; 3,284 sq. yds. on Dickinson St. to Vander Weele Bros., at $15,150; Comstock St., 5,196 sq. yds., to McDermott & Cooper, at $23,359; Morgan St., 1,789 sq. yds., to Vander Weele Bros., at $6,939, also to same contractors the following contracts: 1,534 sq. yds. Valley Ace., at $6,480; 1,084 sq. yds. on Dickinson (Union to Willard) at $4,390; 4,654 sq. yds. on Temple St., at $19,379; 3,054 sq. yds. on Griggs St., at $13,646, and 2,050 sq. yds. Portland Ave., at $10,461.

Mich., Marquette—Marquette County has awarded contract for surfacing State Trunk Line betw. Gwinn and Escanaba, Job 35-8, at $175,000.

Mich., Sturgis—Grace Constr. Co., Fort Wayne, Ind., awarded contract to pave 21 streets in Sturgis, (about 17 miles) at $200,000.

Minn., Detroit—Birch & Sons Constr. Co., Fargo, N. D., awarded contract for paving here, at $138,535. Work is to begin April 1.

Minn., Duluth—D. H. Clough & Co., 707 E. Superior St., awarded contract for paving 2nd St.—4th Ave. W. to 26th Ave E., at $237,837.

Minn., Duluth—D. H. Clough, 707 E. 1st St., Duluth, awarded contract for paving 2nd St.—4th Ave. W. to 26th Ave. E.—at $237,837; Miller & Carlson, 1128 7th Ave. E., awarded contract for paving 10th Ave. E. from 6th to 11th Streets, at $19,309.

Miss., Vicksburg—Reminger & Beauchamp, Vicksburg, Miss., awarded contract by Warren Co. Hwy. Comn., at $22,877 for earthwork and Junkin & Gregory, Natchez, Miss., contract for gravel at $41,623.

Mo., Kansas City—J. F. Welch, awarded contract for conc. paving on Southwest Blvd., at $54,885.

Neb., Oakland — Bauer & Johnson, Omaha, awarded contract for paving in district B, at $100,461; L. L. Beye, El Dorado, Kansas, awarded contract for sheet asph. paving, 1½-in. top and 1½-in. binder, in Dist. No. 2, at $117,270. Work will begin as soon as frost is out of ground.

N. J., Belvidere—Eng. Constr. Co., Walnut St., Phila., awarded contr. by Bd. of Freeholders, Warren Co., for paving 1 mile road from here to Oxford, White Twp., conc., at $108,255.

N. J., Salem—B. Foster Co., 20th & Venango Sts., Phila., awarded contract for reconstructing State Hwy. Route 6, Sec. 5, Shirley-Oldmans Crk., rein. conc., at $254,022.

N. Y., Brooklyn—Contracts awarded as follows for grading, curbing and laying walks on Elmore Pl., (E. 22nd St.) to C. Gallagher, 745 Dean St., $2,739; Lenox Rd., to Castle Bros., Inc., Johnson Pl., $5,706; 19th Ave., to Simonelli & Son, Inc., 28 Conselyea St., Greenpoint, $996; paving Elmore Pl. (E. 22nd St.) and curbing Farragut Rd. to Cleveland Trinidad Paving Co., Flushing, $7,272 and $14,255, respectively. Park Bd. awarded contract to Cranford Company, 52 9th St., for improving Ocean Parkway Traffic Rd. betw. Ave. W and Coney Island Creek brdg. here at $87,355.

N. C., Greensboro—R. G. Lassiter & Co., awarded contract to construct 5.6 miles of road betw. Gibsonville and Kernodle's Mill; 5-in. concrete base and 2-in. Topeka surface, at $115,694.

Ohio, Cincinnati—Chas. F. Ruck and Frank Polking awarded contract for impvt. of Clough Rd., at $89,204; R. F. Cash awarded contract for constr. of Willey Rd. brdg., ot $2,984.

Ohio, Cleveland—R. J. Burke Co., Schofield Bldg., awarded contract for improving Richfield Rd., at $96,093.

Ohio, Columbus—State Hwy. Dept. let contracts for grading, bridging and paving 2.865 mi. Sec. M, Van Wert-Ottawa Rd. and 0.595 mi. Sec. "Ottoville" Van Wert-Ottawa Rd., Putnam Co., Kentucky, rock asph., to Newell & Smith, Defiance, at $70,000 and $14,336, respectively.

Ohio, Columbus—Following contracts let by Dept. Hwys. & Pub. Wks.: For grading, bridging and paving: Wood Co. Sects. "A," "B" and "Haskins," Bowling Green-Waterville Rd., 5.105 miles to Johnson, Van Wagoner & Johnson, Tontogany, Ohio, $83,184; Defiance Co., Sec. A, Paulding-Bryan Rd., 1.872 mi., J. A. Elder, Bryan, Ohio., rein. conc., $52,678; Knox Co., Sec. B-1, Mt. Vernon-Newark Rd., 3.39 mi., mono. brk., Jno. L. Edwards, Sunbury, $114,677; Licking Co., Sec. G, Newark-Mt. Vernon Rd., 4.053 mi., rein. conc., J. F. Stambaugh, Ada, $129,720; Portage Co., Sec. S, Akron-Youngstown Rd., 2.427 mi., bitum. conc., Mahoning Constr. Co., Warren, $73,159; Wood Co., Sec. A, Perrysburg-Fostoria Rd., 2.376 mi., tar macad., W. Sousley, Ada, at $53,049; Fulton Co., Sec. E-2, Bryan-Wauseon Rd., 2.003 mi., rein. conc., D. M. Roach, Defiance, $55,713; Sec. S, Bryan-Wauseon Rd., 1.008 mi., rein. conc., D. I. Roach, Defiance, $27,814; Perry Co., Sec. B, McConnellsville-New Lexington Rd., 3.749 mi., plain conc., W. F. Payne, Springfield, $145,183; Warren Co., Sec. C-1, Columbus-Cincinnati Rd., 4.424 mi., tar macadam, J. W. Weeks, Lebanon.

Ohio, St. Clairsville—F. Amrine. Brookside, awarded contract for paving North Rd.—Hendrysburg to Sewellsville, vitr. brk., at $66,420.

Okla., Sayre—Pearce Constr. Co., Edmond, Okla., awarded contract for constructing 28,000 sq. yds. 6-in. conc. pavement, at $107,500.

Okla., Tulsa—Tulsa County Comms. let road contracts as follows: W. W. Fox, at $154,489 for 5½ miles road beginning at Lewis Ave., running thru Dawson to Morgan's Corner; G. E. Zimmerman, at $61,244, for 3 miles road starting at no. end of Main and Pine; Fuller Construction Co., at $19,834, for 4-mile rd. from city limits on No. Lansing to Pine St.

S. C., Sumter—Slattery & Henry Constr. Co., Greenville, S. C., awarded contract for constructing 4 miles asph. conc. rd. on Sumter-Mayesville Hwy., at $97,579.

Texas, Athens—Smith Bros., Crockett, awarded contracts to constr. 40,000 sq. yds. brick paving at $155,000; also surfacing 12 mi. Hwy. No. 10, at $160,000.

Texas, Bastrop—Bastrop County let contract for grading and gravel surfacing State Hwy. 20, 8.8 miles, Sec. C, to W. C. Moore, Smithville, at $32,718; 9.68 mi. Sec. B, to R. G. Buckner & Son, Cleburne, at $62,573.

Texas, Dallas—Texas Bitulithic Co., awarded contract for Maple Ave. work at $90,411; Central Bitulithic Co., contract for paving Austin St., at $17,028.

Texas, Denison—Julian C. Faild & Co., Box 246, awarded contract for paving streets here at $200,000.

Texas, Marlin—W. S. Dozier, Austin, Tex., awarded contract to constr. 70,000 sq. yds. rock asph. surfacing, at $50,000.

Texas, New Braunfels—Harris & Powell, Marlin, Tex., awarded contract for constr. of 16.62 mi. Hwy. No. 46, crush. rock and gravel surfacing; rein. conc. draing. structures, at $79,802.86.

Texas, San Angelo—Texas Mackenite Co., Ft. Worth, awarded tentative contract for bldg. 4 blocks 20-ft. drive connecting with Sonora pike, Amiesite to be used. $150,000 street paving bonds will be offered for sale.

Va., Norfolk—F. J. McGuire, Paul-Gale-Greenwood Bldg., Norfolk, awarded contract for paving Olney Rd., Monticello, Colley and Newport Aves., Lexington and Starke Sts., at $238,210.

Wash., Spokane—Following road contracts let

calling for expendts. of $134,793: J. E. Edwards will grade and surf. 8.3 mi. Nine Mile Rd., at $71,-423; C. W. Payne & Mitchell Brothers will resurface Pend Oreille Hwy. with crushed rock for 12.31 mi., at $18,090; also approx. 9 miles Central Wash. Hwy. near Cheney and Taylor at $20,500; Sloan Constr. Co. will resurface 6.77 miles northern sect. of Inland Empire Hwy., at $15,375; J. B. Mitchell will resurface southern sect. of same Hwy., near Spangle, at $9,405.

Wash., Spokane—Mohr Constr. Co. awarded contract for 8 miles of rd. including stretch thru Medical Lake and extending southwest toward Tyler, at $66,823.

W. Va., Weston—Lewi Co., paving Broad Run Rd., 28,161 sq. yds. 1-course conc. and 400 sq. yds. Telford base; Hackers Crk. Rd., 28,161 sq. yds. 1-course conc. and 400 sq. yds. Telford base, to E. J. Bitting, care L. Troxwell, Co. Clk. Weston, at $120,550; Hilly-Upland Rd., 42,242 sq. yds. 1-course conc .and 400 sq. yds. Telford base; Haleville Rd., 3,402 sq .yds. 1-course conc., 100 sq. yds. Telford base, to Ferguson Bros. Co., Shinniston, at $107,214.

W. Va., Wheeling—Fred Amrine, Brookside, W. Va., (P. O., Oakland, Md.) awarded contract for paving north road from Hendrysburg to Sewellsville, at $66,420.

Wis., Prescott—Peppard & Fulton, 217 Bd. of Trade Bldg., Superior, awarded contract for constr. of bridge over St. Croix River at Prescott, at $90,-000.

SEWERAGE AND SEWAGE TREATMENT

Ariz., Miami—R. G. Thomas, former town engineer, awarded contract for constr. of 2nd unit of sewer sys. for town, his proposal including purchase of $125,000 sewer bonds and $150,000 gas plant bonds at par.

Cal., Anaheim—Mlagenovich & Gillespie, 1029 W. 36th St., Los Angeles, awarded contract for constr. of sewers in N. Palm and a large number of other streets, at $13,539.

Cal., Banning—R. E. Garretson & Co., 1346 Fairfax Ave., Los Angeles, awarded contract for constr. of Gilman Canyon and Indian Canyon storm drains, at $31,855.

Cal., Culver City—Braun, Bryant & Austin, Inc., 1680 4th St., Santa Monica, awarded contract for constructing portion of sewers, at $2,202.

Cal., Los Angeles—Jno. Sutalo, 476 Camulos St., awarded contract for constr. of cem. pipe sewer in sewer right-of-way west of Madison Ave., at $1,117; P. N. Snyder, 842 S. Harvard Blvd., awarded contract to construct sewers in Wilshire Crest Tr., at about $24,000.

Cal., San Diego—B. B. Boyd awarded contract for sewer constr. on Point Loma, at $15,190.

Colo., Ft. Collins—Arthur A. Dobson Co., Lincoln, Neb., awarded contract for storm water sewer in Dist. No. 6. Lock Joint Pipe Co. is to manufacture the rein. conc. pipe. Bid of Dobson Co. is $82,987.13.

Mo., Springfield—Ralph McSweeney awarded contract for bldg. sewer in Dist. No. 40., Sec. 2, at $7,052. Sewer will include 6,845 ft. mains.

Minn., Cloquet—Pastoret Constr. Co., Sellwood Bldg., Duluth, awarded contract for sewers and water mains on 17th St., at $7,776.

Ohio—Columbus—Gaty Constr. Co., Central Natl. Bank Bldg., awarded contract for 11,130 ft. 12-72-in. conc. trunk sewer in Wilson Ave., at $88,939.

Ohio, Lakewood (Cleveland P. O.)—Gallagher & Burke Constr. Co., 1339 Irene Ave., for 1,500 ft. 45-in. brick sewer in Lakeland Ave., at $27,046.

Pa., Philadelphia—Following contracts let for sewer work: Vincent S. Perna, contr. for constructing branch sewer on Emily St.—Percy to 9th St., $1,300; constructing branch sewer on Blaine St.—Hunting Park Ave. to 20th St., $1,900; O'Neill Co., for constructing branch sewer on sect. of Broad Ave., at $36,500; J. Jos. McHugh, for constructing branch sewer on Columbia Ave., at $5,600; Jno. McCool, for constructing branch sewer on Fourth St., at $7,500; David Lupton's Sons Co., for furnishing steel sashes, etc.

S. D., Woonsocket—J. W. Welt, Bancroft, Neb., awarded contract for constr. work on Sanborn County's draing. project, at $70,000 City of Artesian being in 29th draing. dist., becomes an integral part of county project. City will use sewer pipe while county system will work with drain tile. Work will start in Spring. Drainage will reclaim about 11 sq. miles of farm lands. Ditch work will be done by tiling machines.

Texas, Amarillo—Gordon Construction Co., Denver, awarded contract for constr. of approx. 9 miles extensions at $15,105. Vitr. clay pipe, 6, 8, 10 and 15 ins. in diam. is to be used in making the extensions and is to be laid at depths ranging from 3 to 21 feet.

Texas, Dallas—Smith Bros. Construction Co. awarded contract for laying storm sewer and sanitary sewer on Pacific Ave., at $271,625.

Texas, Ft. Worth—H. W. Greenway awarded contract to construct intercepting and collector mains for sewage disposal plant; precast conc. pipe, at $187,891.

Texas, Ladonia—Sherman Machine & Iron Works, Oklahoma City, Okla., awarded contract to extend sewer and water systems, at $39,319.

Va., Richmond—C. I. Henley awarded contract for pipe work in Mark Division, at $5,301 and at $41,777 for pipe work in Oak Grove; to R. M. Lane, at $39,592 for work in Providence Park; A. W. Maynard, at $6,972 for pipe work in James and Buchanan Sts., and to A. M. Guion, at $65,297 for cement blk. work in Highland Park.

W. Va., Huntington—W. J. Griffith awarded contract to construct 1,080 ft. 12-in. vitr. tile lateral sewer and manhole in 3½ alley, betw. 27th and 28th Sts., at $4,376.

Wash., Seattle—Paduano & Co. awarded contract for sewers (conc.), at $5,149.

Wash., Wenatchee—Council voted to award contract for south end sewer to Standard Asphalt Paving Co. Contractor bid $109,815 for conc. pipe and $109,922 for vitr. pipe. Special meeting will be held by Council to decide on material to be used.

WATER SUPPLY AND PURIFICATION

Cal., Glendale—Dept. Public Service was awarded the contract for laying 1,185 ft. 6-in. and 543 ft. 4-in. cast iron water pipe, at $2,800.

Cal., Glendale—Dept. Pub. Service submitted only bid at $13,500 and was awarded contract for laying 4,630 ft. 8-in. and 330 ft. 6-in. water pipe in Brand Blvd. and Cerritos Ave. betw. Windsor Rd. and San Fernando Rd.

Cal., Long Beach—Sidney Smith, 2025 Bay St., Los Angeles, awarded contract for furnishing materials and constructing water system in Tract 4495 for the J. Bixby Co., Long Beach, at $5,000. Contr. will require about 4,000 ft. 4-in. Cl. B cast iron pipe and abt. 500 ft. 2-in. stand. screw pipe.

Cal., Los Angeles—Adams-Pipe Works awarded contract by Huntington Land & Import Co. to furnish 4-in. Cl. B cast iron water pipe and fittings for water sys. in a tract near Alhambra, at $4,500.

Cal., Seal Beach—Sidney Smith, 2025 Bay St., Los Angeles, awarded contract for constructing water distributing system for Seal Beach, at $35,197 for cast iron pipe laid with cem. joints, and $36,913 with lead joints, involving 17,275 ft. 2-in. stand. screw pipe, 12,125 ft. 4-in., 5,410 ft. 6-in., and 208 ft. 8-in. Cl. B cast iron pipe, necessary valves and 8 4-in. fire hydrants.

Ont., Guelph—Goldie McCulloch Co., Galt, Ont., awarded general contract for pumping equipment, at $25,000.

Ont., Kitchener—Water Comn. awarded following contracts for materials and equipment to be used in proposed Strange St. water works installation: Canadian Blower & Forge Co., Kitchener, one set consisting of 1½ million gals. centrif. pump direct connected to one 4-cycle G. R. C. Sterling gasoline engine, at $4,325; Storey Pump & Equipt. Co., Toronto, one set consisting of 1½ mil. gal. centrif. pump direct connected to one 125 h. p. Westinghouse Induction motor, $3,230; Laurie & Lamb, Montreal, 2 sets consisting of 1,000 cu. ft. air compressors direct-connected to 200 h. p. Westinghouse Anychronous motors, together with an 8-cycle G. R. C. Sterling gasoline engine as auxiliary drive, at $27,730; Norton Steel Works, Ltd., Bridgeburg, Ont., a one-million gal. steel reservoir complete with foundation erected, at $24,154.

B. C., Vancouver—Nickerson Constr. Co., 519 Winch Bldg., awarded contract for extensive repairs necessary for complete restoration of New Westminster water works system, at $175,000.

Iowa, Indianola—Wm. Danforth, St. Paul, awarded contract for digging and walling new city well on South river bottom, at $8,700.

Iowa, Lost Nation—W. B. Carter, U. B. Bldg.,

Sioux City, awarded contract for disposal plant, at $11,900.

Iowa, Manning—W. B. Carter, 606 United Bank Bldg., Sioux City, and Bessemer Gas Engine Co., Omaha, Neb., awarded contract for pump house, 2 engines, 2 pumps, 1 well, 1 oil tank, $17,995.

Fla., Clearwater—T. S. Lord, Dunedin, Fla., awarded contract to extend san. sewer system and install ejector plant, at $9,285.

Ga., Atlanta—Case & Cothran, Chandler Bldg., awarded contract for complete filter plant at Hemphill Sta., Secs. 1, 2 and 3; Sec. 2 sublet to N. Y. Continental Jewel Filtr. Co., Flatiron Bldg., New York; Sec. 4 to Nichols Co., Trust Bldg., Ga. Bldg.

Ky., Bowling Green—Fairbanks, Morse & Co., Chicago, Ill., awarded contract to improve water works; install 2 units; 4 cylinders each, semi-Diesel engine, 1 motor, generator and 2 pumps, at $47,584.

Minn., St. Paul—H. W. Austin, City Purch. Agt., awarded contracts for 1,288 tons Cl. B. c. i. pipe to Natl. Cast Iron Pipe Co., Birmingham, Ala., av. abt. $44.40 per ton f. o. b. St. Paul; 148½ tons miscellaneous c. i. water specials to St. Paul Foundry & Mach. Co., 209 Essex Bldg., $100 per ton; 300 coils ⅝-in., 200 coils ¾-in., 50 coils 7-in. and 50 coils 1½-in. extra strong lead pipe to Natl. Lead Co., 404 Willius St., $5.65 per cwt.; 39 tons water specials to South Park Fdry. & Mach. Co., 209 Essex Bldg., $95 per ton del.

N. C., Highland—Jno. N. Bohannon awarded contract to lay water mains, at $18,400.

N. Y., Jamestown—U. S. Cast Iron Pipe & Foundry Co., 71 Bway., N. Y., awarded contract for c. i. and steel pipe and fittings, at $35,000.

Ohio, Brookpark—Gangl Constr. Co., 737 2nd Natl. Bldg., Akron, awarded contract for 16,500 ft. 8-12-in. cast iron mains, at $52,412.

Texas, Floydada—Sherman Machine & Iron Works, Oklahoma City, awarded contract for water works extension, at $23,000.

Texas, Ladonia—Sherman Machine & Iron Works, Oklahoma City, Okla., awarded contract to extend water and sewer systems, at $39,319.

Texas, Port Arthur—National Cast Iron Pipe Co., Birmingham, Ala., awarded contract for pipe for water extensions, at $51,752.

Wash., Seattle—S. A. Moceri awarded contract for water mains in Wilson Ave., et al., at $22,584; A. Tocco & Co., contract for water mains in Corson Ave., et al. at $31,394.

Wash., Seattle—Following contracts let: Rensselaer Co., awarded contracts for hydrants, 8-8-in., at $1,000; Olympia Foundry Co., 20-20-in. flexible joints, at $4,040 and bends and tees at $729.10; also wyes, crosses, tees, hydrant tees, etc., at $719.80; U. S. Cast Iron Pipe & Foundry Co., contract for flange pipe, at $3,867.50; American Cast Iron Pipe Co., awarded contract for furnishing cast iron pipe for Water Dept., at $100,813.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—City and Jefferson Co. plans constr. of 15 miles asph. paving to connect city's paved streets with county's paved highways. A. J. Hawkins, City Engr.; Claude Rogers, Co. Hwy. Engr.

Ark., Charleston—Franklin Co. will complete section of Little Rock-Fort Smith Hwy., known as Franklin Rd. Dist. No. 1; 24 miles graveled rd., 15 ft. wide. Cost about $300,000. R. C. Limerick, St. Hwy. Engr., Little Rock.

Ark., Pine Bluff—New paving district created which embraces 5 blocks. Street is to be paved with conc., asph. or other material property owners may designate. Report received from Commrs. of Paving Dist. 52 (36 blocks). Est. cost of paved in this Dist. is placed at $150,000.

Cal., Glendale—City Trustees have decided to pave both sides of Brand Blvd.—4 or 5 blks.—betw. Colo. Blvd. and old Tropico city limits at 10th St. with either Willite or asphalt on conc. base; also to start proceedings for paving Central Ave. betw. Broadway and San Fernando Rd.—about 1 mile—this street having only narrow strips of macadam down center.

Cal., Stockton—Constr. work on Victory transcontinental hwy., which begins immediately weather conditions permit. As soon as the snow melts state of Nevada will launch constr. program calling for expendt. of $1,500,000. Program definitely adopted by State Hwy. Comn. and Co. Commrs. $800,000 of this sum will be spent on worst sections of Victory Hwy. in Nevada. Road will be graded 24 ft. wide, surfaced with gravel and draing. structs. erected. From Reno to Calif. line hwy. will be paved with conc. 18 ft. wide. Hwy. Commr. Geo. C. Mansfield of California reports that work will start on state's primary road during coming season. Work will consist of paving road from Auburn to Colfax, elimination of Donner summit and constr. of Dog Valley grade. Cal. Hwy. Comn. has allotted $150,000 for impvt. of road east from Willows to Glenn.

Ont., Toronto—Plans being prepared for paving St. Clair Ave. and Grange Roads and Gloucester, John and Pembroke Sts.—asph. on concrete, $277,-305. Plans to pave also and curb and gutter Yonge St.—Heath to city limits, $557,566; Teraulay St.—College to Danvenport Rd., $240,896; Dundas St.—Yonge to Victoria Sts.

Colo., Colorado Springs—Red Mountain road, heavy grade near Red Cilff, and a part of the Pikes Peak Ocean-to-Ocean Hwy. system, will receive $100,000 fed. aid during year. Other projects included in 1922 program, together with est. fund to be expended on each, are as follows: Berthoud pass, $140,000; Durango-Silverton Hwy., $26,000; Red Mtn. road, $100,000; Cumbres pass, $130,000; Cameron pass, $71,000; No. Hardscrabble rd., $60,-000; Independence pass, $35,000; Grand Mesa, $50,-000 ,and Arapahoe Glacier Rd., $45,000.

Ga., Columbus—Muscogee County plans paving Benning Rd., at cost of $200,000; also hard surfacing 18 miles Cusseta Road. J. R. Key, Chrmn. Comn.

Idaho, Sandpoint—Bonner County will expend $295,000 on road impvts. this year. Dist. Forester Fred P. Morrell has agreed to recommend to the forest service that $125,000 be set aside for constr. of Kootenai-Cabinet road of Clarks fork state hwy., county to put $65,000 into the work; also $15,000 into constr. of W. Branch road of Kaniksu forest in Priest River country. Commr. of Pub. Wks. W. J. Hall has agreed to allot $25,000 of state's fed. aid money and $27,500 of state aid money to completion of North and South hwy. proj. no. of town, 4 miles of which are uncompleted. County will put $27,500 into this proj. which includes bldg. steel rein. conc. brdg. across Sand Crk. near city limits of Sandpoint.

Ill., Benton—Surveys being made for paving ¼ mile So. McLeansboro Rd. Paving Dist. No. 13; 10,-000 sq. ft. curbing. Est. cost, $50,000. C. B. Mautz, City Engr. Town also plans 20 miles 2-course conc. sidewalks, 4 ft., $175,000.

Ill., Chicago—Hyde Park is to have new blvd.—Wash. Park to East Erd Park and outer lake shore drive. The 53rd St. Prop. Owners' Assn. is back of movement to have So. Park Comnrs. take over East 53rd St. and boulevard it from Cottage Grove to the lake.

Ill., Joliet—Council passed resolution for paving number of streets of west side. Est. cost, $94,419.

Ill., Lewistown—Fulton County received bids about April 10 for paving 3 miles of roads in Canton Twp. E. F. Motsinger, Canton, Engr.

Ill., W. Frankfort—Plans being made for Paving Dists. Nos. 8 and 12, vitr. brick on concrete; $200,-000. E. A. Fox, Court House, Engr.

Ill., Wheaton—Bd. local Impvts. making plans for paving N. Main St. and various other streets with vitr. brick on conc.; $85,000. L. J. Ruddock, Court House, Engr.

Ind., Indianapolis—Lawrence Lyons, Chmn. of St. Hwy. Comn., has assured Secy. Greenebaum of Michigan City Chamber of Com., that constr. of Dunes Hwy.—Mich. City to Gary—will begin early this Spring.

Iowa—Davenport—25 miles of paving for 1922 is program outlined by City Council, according to resolutions passed at meeting. Est. aggregate cost of proj., $827,000. Of the 25.3 mi. scheduled to be surfaced, 13.6 miles is to be new paving, while the remaining 11.7 miles will be resurfaced.

Ky., Louisville—Board Pub. Wks. will construct abt. 1 mile streets, including 8th, 18th, Baxter Ave., etc.; $200,000.

Md., Baltimore—City plans new paving on Washington Rd. from old to new city line; Guilford Ave. —32nd to University Parkway; Lombard St.—East

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Bruces, Extension.
Kalamazoo Fdy. & Machine Co

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Daw & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W
Hunt & Co., Robert W.
Janes, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

to Third Ave.; Highland Ave.—Philadelphia Rd. to Monument St.; Hillsdale Rd.—Forest to Liberty Heights Ave.; East Driveway of Gwynn Oak Ave. to Ridgewood Ave., etc.; $1,500,000 available from General Impvt. Loan. R. Keith Compton, Chmn. Paving Comn.

Mich., Bad Axe—Huron County had plans prepared for 3 miles Cl. B or C gravel road, 12 ft. and 6 miles Cl. B road, 9 ft., in Owendale, Windsor, Brookfield, Filion and Meade Twps.—53,000 sq. yds. surfacing, $50,000. W. W. Lavers, Bad Axe, Engr.

Neb., Lincoln—Will take bids in Spring on approx. $2,000,000 state and federal aid road work in various counties. Geo. E. Johnson, Sec. Dept. Pub. Works, Lincoln.

Mich., Benton Harbor—City Comn. has decided that resurfacing of Territorial rd.—Water St. to city limits; E. and W. Main Sts.; paving Elm St.—8th to 9th Sts.; Cedar St. and Broadway from Empire to Britain Aves.—will start by April 1st. Engineer's plans for resurfacing Territorial Rd. with Willite or asph. estimate cost at $35,000. Elm St. will be paved with brick on conc. Bway. will also be paved with brick on conc. from Britain to Empire. Est. cost of paving Broadway, $43,066.

Mich., Lansing—State will receive approx. $2,500,000 from Fed. Govt., which will be expended by the state highway department on 237 miles of roads in state. Added to this amt. there will be added an equal amt. from State hwy. dept. and various counties, making about $5,000,000 in all to be expended on Fed. Aid roads in 1922.

Minn., Minneapolis—City expects to spend $1,500,000 for paving during 1922. Elwell bonds, to amt. of $1,200,000 will be sold this month or early in March for paving provisions of Elwell law. In addition city has funds available for abt. $300,000 of paving under 5-yr. law. Bids have been ordered on creosote block and this and other material required for paving program will be purchased just as soon as funds are available.

Mont., Helena—Following road constr. program recommended to St. Hwy. Comn. by Chief Engr. Jno. N. Edy: Dist No. 1, 25 miles, SW Mont., $275,000; Dist 2, Great Falls Dist., 96 miles, $736,000; Dist 3, N. Montana, 27 miles, $206,000; Dist. 4, SE. Mont., 65 miles, $473,000; S. Central Montana, 21 miles, $22,000; total, $1,912,000.

N. M., Albuquerque—Dist. Office of Forest Service has received state's share of forest rd. fund. Total amt. is $588,271, of which $338,619 will be expended in roads of primary importance for state, county and community development. Remaining $219,652 will be used to construct roads and trails needed for forest protection and administration.

N. C., Greensboro—Guilford Co. Comnrs. will sell $1,000,000 bonds for road constr. J. A. Rankin, Chrmn.

N. C., Kinston—Ctate. Comn. is preparing to pave roads leading from Lenoir Co. boundaries to Ft. Barnwell, Craven Co., and Trenton, county seat of Jones. Paving will be about 17 miles in length and will cost several hundred thousand dollars.

N. C., Orangeburg—City will spend approx. $250,000 for street paving within immediate future; 109,973 sq. yds. conc. or asph. paving will be laid.

N. C., Waynesville—Town plans additional paving and storm sewers at cost of $150,000. Carolina Engrg. Co., Engrs., Wilmington, N. C.

N. D., Schafer—Board of McKenzie Co. Comnrs. has appropriated $50,000 for improving Parks Hwy. thru county. H. H. Johnson, Aud.

Ohio, Cleveland—Street paving and repair work will be started here by April 1st. Direct. of Pub. Service Maline reports that Dept. has $250,000 available for this work, and assessments from property owners will make fund $1,800,000, thereby making possible the paving of 100 streets.

Ohio, Lima—City will start work soon on paving program to cost approx. $250,000.

Ohio, Springfield—Will open bids about April 1st for paving Belmont St.—Main to Cleveland, Cincinnati, Chicago & St. Louis R. R., brick, conc. or asph., $45,000; repaving E. Main St.—Spring to Freeman Sts., and from end of paving to tracks of Detroit, Toledo & Ironton R. R., asph., conc. or sheet asph., $50,000. E. E. Parsons, City Engr.

Okla., Okemah—Okfuskee Co. Comnrs. will vote March 21 on issuance of $500,000 bonds for constructing 71 miles hard surfaced roads.

R. I., Naragansett—Town considering issuing bonds in sum of about $75,000 for new road construction. Private plans.

R. I., Westerly—Plans to repair and construct new permanent pavements at cost of $65,00. Private plans.

Texas, Crockett—Houston Co. plans constr. of 10 miles Kings Hwy.; cost $200,000. G. W. Courter, Cons. Engr., Marlin, Tex.

Texas, Jefferson—$500,000 bonds voted in Marion Co., for road work. This will be supplemented by $225,000 of Fed. Aid for purpose of bldg. State and Fed. Hwy. thru Marion Co.

Texas, Houston—City budget calling for expendt. of $4,280,528 passed by council. Although program for street graveling has not been mapped out, it is expected City will spend $200,000 on this work; $80,000 will be spent on repairs and renewals to paved streets and $45,000 for widening and extending streets.

Texas, Tyler—U. S. Bureau Pub. Rds., Washington, D. C., approved proj. statement of Fed. Aid Proj. 197, involving constr. of 20 mi. Hwy. No. 37 at cost of $273,000. D. K Caldwell, Co. Engr.

Utah, Salt Lake City—Work on Magne-Tooele Road will begin in April. Road will cost approx. $211,000, of which Salt Lake Co. will pay approx. $54,000. E. L. Burgon, Co. Comnr.

Wash., Olympia—Betw. 130 and 140 miles grading and graveling and more than 60 miles paving are on state's hwy. program for 1922, involving expendt. of approx. $6,000,000. Jas. Allen, State Supvr of Hwys. Construction for the most part will be towards the impvt. of the 8 great arterial hwys., namely, Pacific, Sunset, National Parks, Olympia, Navy Yd., Ocean Beach, No. Bank and Inland Empire Hwys. Fed. Aid appropriation of $1,103,000 now available, combined with appropriation after next July will give state approx. $2,000,000 of fed. money for use this year for road purposes.

Wis., Dodgeville—Iowa County had plans made for grading, surfacing with mine tailings and bldg. culvts. on Dodgeville-Mineral Point Rd. Proj. 180. Length, 4.25 miles. T. W. Reilly, Div. Engr.

Wis., Madison—City Council has recommended paving of 36 streets. City Engr., E. E. Parker; City Clk., O. S. Norsman. Est. cost, $570,743.

Wis., New Richmond—Plans paving 1.7 miles Main St., bitum. conc., conc. curbs and gutters; $50,000.

Wis., Oshkosh—Will take bids in April for paving 15,000 sq. yds. Oakwood Ave., Linwood Court, Otter St.—Bowen to Rosalin Sts., Monroe Ave.—North Park to Wash. Sts., Congress St. from Algoma Blvd. to Elm St.; Grant St.—Algoma to Vinland St.; Jefferson Ave., Tenn. to Irvington Sts.; Knapp St.—4th to Durfee Sts.; 18th—Oregon to Doty Sts.; 1 and 2-course bitulithic conc., conc. or tar macadam. G. Randall, City Hall, Engr.

Wis., Phelps—Vilas County will start work in Spring on widening and cutting new route thru hills from Phelps to Lac Vieux Desert. Wm. Hunter, Eagle River, Co. Comnrs.

Wis., Shawano—Shawano County will grade, drain and gravel about 12 miles, probably by day labor. St. Div. Engr. C. C. Rollman, Green Bay. W. F. Meyer, Co. Hwy. Comnr, Shawano; $60,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Stockton—Plans and specifs. for stormwater sewers to be installed in "Fair Oaks North" and on Oak, Channel, Church, Hazelton, Clay, South, Madison and several other streets, approved by City Council. Work planned in 'Fair Oaks No." will afford practically an entire system, while only short lengths of pipe will be installed on last named streets.

Conn., Bridgeport—Plans san. and storm sewers in portions of Park and Grand Sts., Wilmot and Ridge Aves.; $100,000. J. A. McElroy, City Engr. Also san. sewers in Mt. Grove, Bryant, Siemon and Hubbell Sts., Davis and Sage Aves., at cost of $250,000; storm sewers in Bethany Dist., Black Rock, North Park Ave., Lindley and Grant Sts.; $350,000. J. A. McElroy, City Engr.

Fla, Clearwater—City will install and improve sanitary sewers; $25,000 bonds voted; install storm sewers and pave streets; $84,000 bonds.

Fla., Orlando—$340,000 bonds voted here for installation of sewer system and septic tanks.

Ill., Chicago—Sanitary Board authorized A. W. Dilling, Chf. Engr. Sanitary Dist., to construct conduit confining Bubble Crk., along W. 39th St.—Halsted to Racine. Est. cost of proj., $1,500,000.

Ill., Elmwood Park (Chicago P. O.)—E. Hancock,

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Canneiton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Fine Liners.
Canneiton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Reeter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harrie Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Engr., 2047 Ogden Ave., Chicago, will take bids about August for sewers in various streets here, to cost about $300,000.

Iowa, No. English—Bids close about May 1st for san. sewers. Approx. 3 miles 8 to 12-in. pipe and 1 mile 6-in. pipe; disposal plant. Eng. H. R. Green, 634 Cedar Rapids Savings Bk., Cedar Rapids, preparing plans. W. M. Lawler, Mayor.

La., Covington—Surveys and estimates completed for sewerage and water systems for Covington by Engr. Xavier Kramer, and are now in hands of committee. Est. cost, $122,000.

Md., Baltimore—City plans expendt. of $250,000 to install complete san. sewer system at Govans. Henry G. Perring, Chf. Engr.

Mich., Sturgis—Plans 13,700 ft. 8, 10 and 12-in. vitr. sewers; $30,000. Will purchase and furnish pipe. A. H. Niles, Sturgis, Engr.

Mo., Cape Girardeau—City preparing plans for 8-in. 3½-ft. vitr. clay sewers and 200 brick manholes with steel covers; $315,000. E. Siler, Court House, Engr.

Mo., St. Louis—City will reconstruct sewers; plans voting on August 1st on $4,000,000 bonds. Louis P. Aloe, Pres. Bd. of Aldermen.

Neb., Lincoln—Plans submitted for sewage disposal plant. Filter beds and stone filling; est. $100,000. Abt. 700 cars rock. Theo. H. Berg, City Clk.

N. Y., Brooklyn—Jamaica Board of Trade, Sewer Comnr. Jno. R. Higgins, and engineers of Queens Sewer Dept., agree that Jamaica sewerage system is menace to health and favor installation of new "combined" system, which would include both storm and san. disposal. Board of Trade intends to confer with city's chief engineers and then urge Board of Estimates to consent to installation of entirely new sewerage system.

N. C., Troy—City will improve water and sewer systems. Will issue $125,000 bonds.

N. C., Waynesville—City plans expending about $150,000 to extend sewer system and pave streets. Carolina Engrg. Co., Engrs., 410 Southern Bldg., Wilmington, N. C.

Okla., Oklahoma City—City will improve sewer systems; voted $1,000,000 bonds. Mike Donnelly, Comnr. Accountg. & Finance.

Tenn., Johnson City—City will expend about $300,000 to constr. sewers, curb and gutter; pave streets, etc. Will issue bonds. W. O. Dyer, Engr.

W. Va., Spencer—City plans constr. of intercepting sewer, pumping station and treatment plant. C. E. Collins, Engr., Drexel Bldg., Philadelphia, Pa.

WATER SUPPLY AND PURIFICATION

Cal., Avalon, Catalina Isl.—The $158,000 bond issue for both fresh and salt water systems carried at special election.

Cal., Long Beach—City Manager Hewes has reported to Council tentative plan for water system for northwest section of City. He estimates cost of well, pumping plant and pipe line at $50,000 and cost of distributing system at $250,000.

Cal., San Francisco—Supvrs. Pub. Utilities Comn. ordered contr. drawn up between City and Spring Valley Water Co. under terms of which Company will construct pipe line across bay that will supply 24,000,000 gals. water daily; water to be piped from Company's Alameda reservoir. Before Company can deliver this quantity of water it will have to complete the Calaveras dam and build flume to carry water from Niles Crk. tank to Irvington, Alameda Co. Est. cost of both undertakings approx. $1,650,000. City will build 60-in. conc. and steel conduit from Irvington, Alameda Co., to Crystal Springs Lake, San Mateo Co. This will cost abt. $4,000,000, according to est. furnished by City Engr. M. M. O'Shaughnessy.

Cal., Vallejo—Revised plans prepared for constr. of works for Gordon Valley Water Proj. including 18 miles wood stave pipe aqueduct, 26-in. diam., earthen dam with clay puddle core, 80 ft. high, 800 ft. long on top and 200 ft. long on bottom, to have conc. head-gate, $500,000. C. E. Grunsky, 57 Post St., San Francisco, Engr.

Ont., Ottawa—Plans new mains in various sections of City at cost of $100,000; overland pipe line from present terminus at Champagne Ave. to connect with Queen Street pumping station, $160,000; water meters, $30,000. F. C. Askwith, Deputy Engr.

Ont., Scarboro Bluffs—Pub. Utilities Comn. has announced that an 8-in. water main would be placed from pumping station and extend 4 mi. to Scarboro Golf Club, with view to running smaller extens. from that point.

Fla., Orlando—City will purchase, rehabilitate and extend Orlando Water & Light Company's plant; $975,000 bonds voted.

Iowa, Cedar Rapids—Plans completed for reservoir, Grand Ave. and Bever Park. Elec. March 27 to vote $450,000. Engrs., Hatton, Holmes & Anthony, 323 Masonic Temple, Cedar Rapids. City Clk., L. J. Storey.

Ky., Hazard—City will install water works, including pump sta., filtration plant, reservoir and distribution system; also install sewerage system with sewage disposal plant. J. N. Chester, Engr., Pittsburgh, Pa.

La., Covington—City considering purchase of water and sewerage systems of St. Tammany Ice & Mfg. Co., and extending at cost of about $125,000. Henry A. Mentz, Engr. Xavier A. Kramer, Cons. Engr., Magnolia, Miss.

Md., Chevy Chase—Plans being prepared for water line extension and pumping station. Approx. $175,000.

Md., Baltimore—City Pub. Impvt. Comn., (Robt. Garrett, Pres.) approves plans for addn. to filter. plant at Montebello. Plans expendt. of $1,200,000 to install new filters, settling and coagulating basins and filtered water reservoir; increase plant daily capy. from 128,000,000 to 203,000,000 gals. Mayor Wm. F. Broeming, Pres Bd. of Awards; Wm. A. Megraw, Water Engr.

Md., Baltimore—City will extend water works; lay 20-in. main connecting northern suburbs with general system, lay main on Reisterstown Rd. to new city line; later construct feeder mains; construct main at Russell and Bush Sts.; $2,500,000 available. Henry G. Perring, Chf. Engr.

Md., Frostburg—City planning addition to water works system to cost approx. $250,000. W. Harvey, City Engr.; Norton & Whitman, Munsey Bldg., Baltimore, Engrs.

Mass., Boston—Immediate constr. of $60,000,000 reservoir west of Worcester, to supply water to cities and towns within 10-mile radius of Boston, recommended to Legislature in report by joint board of state dept. of health and metropolitan water and sewerage board. Capy. of new reservoir as recommended is 400,000,000,000 gals.

Minn., St. Paul—Making plans for water works impvts., including main extensions, work on filtr. plant, etc. Est. cost, $600,000. O. Claussen, City Engr.

N. Y., Lockport—City contemplates bldg. filtr plant and reservoir at cost of $230,000. R. B. Rhodes of Dupont Co., Fulton Blk., Pittsburgh, Pa. Engrs.

N. C., Elizabeth City—W. H. Weatherly & Co will issue $75,000 water works bonds and install independent water system.

N. C., Hendersonville—City will construct water works; $400,000 bonds issued. C. E. Brooks, Chrmn.; Gilbert C. White, Co. Engr., Durham.

N. C., Kernersville—Town contemplates expending $90,000 to install pumps, etc. Carolina Engrg. Co., Engrs., Wilmington, N. C.

N. C., Lexington—City has issued $425,000 bonds. Will construct water works to Yadkin River. Gilbert C. White Co., Engrs., Durham.

N C., Raleigh—City will improve water works; construct 400,000,000 gal. daily capy. impounding reservoir, 600,000-gal. steel tank and pipe stave line. W. C. Olsen, Engr. Issue $200,000 bonds.

Ohio, Lima—City Comn. has announced plans to extend water mains to all sections of City at a cost of $200,000.

Okla., Ardmore—$300,000 bonds voted for extension of water works.

Okla., Slick—Engineers are preparing for installation of water and sewer systems for town, a part of the $300,000 impvts. recently voted.

Pa., West Chester—At meeting of Boro. Council plans for immense pond for water conservation adopted, and constr. work will start in Spring. Pond will be located on Chester creek, above Milltown. Plans approved by state authorities. Pond will cover large territory; will be three-quarters of a mile in length by a quarter of a mile wide with depth of 20 ft. at breast to five at upper portion.

R. I., Pawtucket—Bd. of Water Comnrs. considering expendt. of $200,000 for new water works construction.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co (Indiana)
The Texas Co

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

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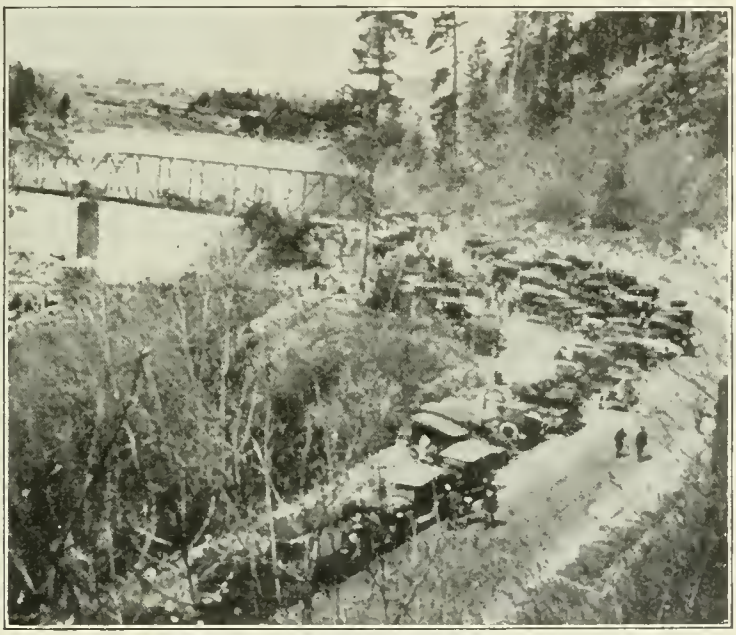

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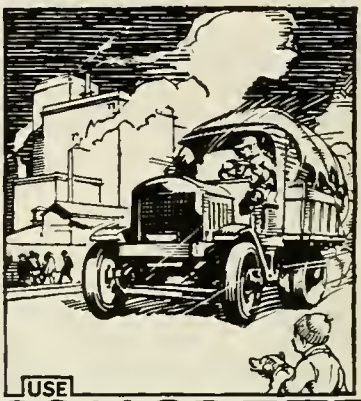

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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXII. APRIL, 1922 No. 4

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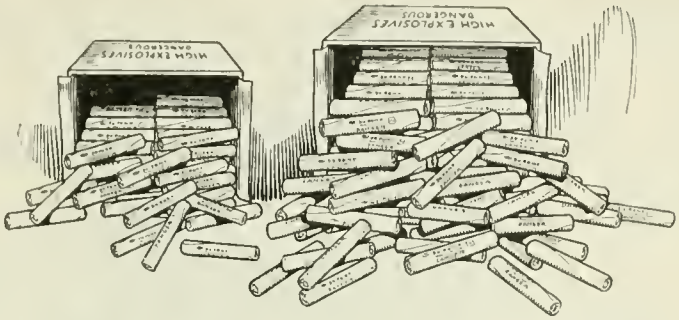

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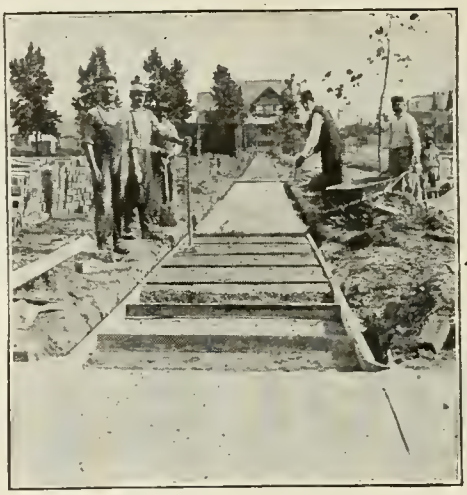

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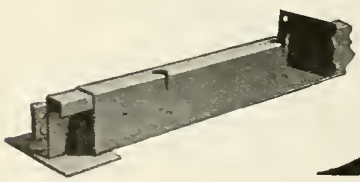

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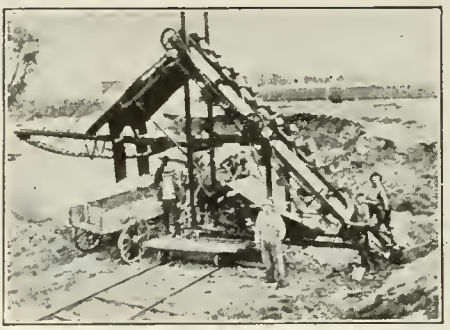
The Michigan Jr. Gravel Screener and Loader

Takes Gravel out of Pit or Pile, Screens out Sand and Stones and Loads the Gravel into Wagons or Trucks.



Several Counties have Purchased Eight or Nine Machines

AGENTS WANTED

The Michigan Jr. holds the low record of cost of handling screened gravel from pit to wagon or truck. This is the all-important consideration, Mr. Contractor. This saving is your profit.

Machine runs up and down side of pit or pile on a track and takes off slice of about ***four*** ft. each time. After going along track once, track is moved over and loader returned along side of pit or pile.

The Screener and Loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

Machine has elevating capacity of ***one yard per minute***, and the only operating expense is salary of three men, under ordinary conditions. One operates machine and two break down embankment.

Sand and stone are conveyed 20 ft. away and do not have to be moved. Machine moves under own power. Easily moved from one pit to another. It is all steel, engine enclosed. ***Saves $30 to $50 a day*** in expenses and makes money in handling gravel.

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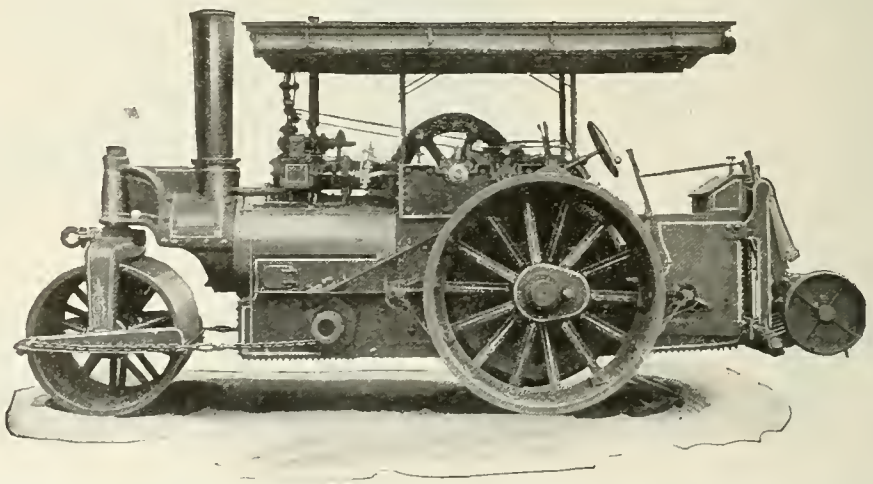

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SPRINGFIELD, OHIO

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the Heavy Duty Mixer

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Preference Given Asphalt Filler for Brick Pavements

The National Paving Brick Manufacturers Association has officially declared its preference for asphalt-filled brick wearing-surfaces for streets and highways *without prejudice to any other type of filler which may be specially adaptable to local conditions.*

The Resolution is as follows:

Whereas: The National Paving Brick Manufacturers Association through its contact with the requirements of the paving market, maintained through the members and field engineers of its Territorial Associations, is increasingly conscious of the trend in engineering design and construction toward asphalt filler, and:

Whereas: Recent investigation discloses that approximately sixty percent of all brick pavements laid in 1921 were so filled, and:

Whereas: The Association interprets this increased proportion of asphalt-filled brick pavements as indication that the majority of engineers and public officials, using vitrified brick for paving, believe that the use of such filler, under specifications providing quality and method of using according or equal to those of the National Paving Brick Manufacturers Association, is calculated generally to insure the construction of brick pavements equal in endurance and economy to the endurance and economy inherent to the individual brick as manufactured, and:

Whereas: It is the traditional policy of this Association publicly to declare its judgment, from time to time, in respect to purposes which it regards as encouraging the wisest use of public funds for paving purposes, therefore:

BE IT RESOLVED: That the National Paving Brick Manufacturers Association, assembled in annual conference at Pittsburgh, Pennsylvania, on December 7, 1921, hereby expresses its confidence in asphalt-filled brick wearing-surfaces for street and highway paving properly designed and built with acceptable materials and thorough methods. And that this Association hereby declares its preference for the asphalt-filled types of wearing surface—

PROVIDED: Preferment of the foregoing type of brick wearing-surface for general use shall be without prejudice to any other type which may possess peculiar adaption to special local conditions.

The burned-in service value of vitrified Paving Brick is matched by the aggressive Public Service spirit of the Paving Brick industry.

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Installing Elastite completely is an easier, quicker job than setting spacing-boards, only a single preparatory step in making a "poured joint" of any type. Elastite saves time, labor and expense, and never needs "repouring" or repairing.

Elastite is the proved, accepted expansion joint for brick, concrete, granite and wood-block paving, cement sidewalks, and all concrete construction of large area.

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40 Wayne Ave. Cincinnati, Ohio

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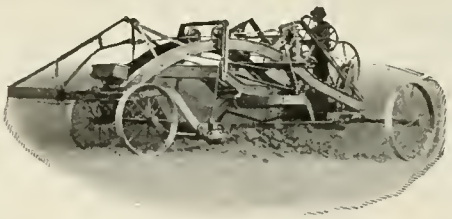

A-W Graders
AND
GRADER-SCARIFIERS
14 Models

You don't have to look further than the first twenty-one pages of General Catalog No. 21-O to find the machine exactly suited to your needs.

The graders range in weight from the Midget at 1,000 pounds to the No. 20 at 9,000 pounds.

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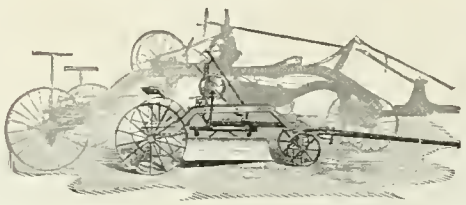
It will pay you to read the whole story of Austin-Western Graders.

Send for Catalog No. 21-O.



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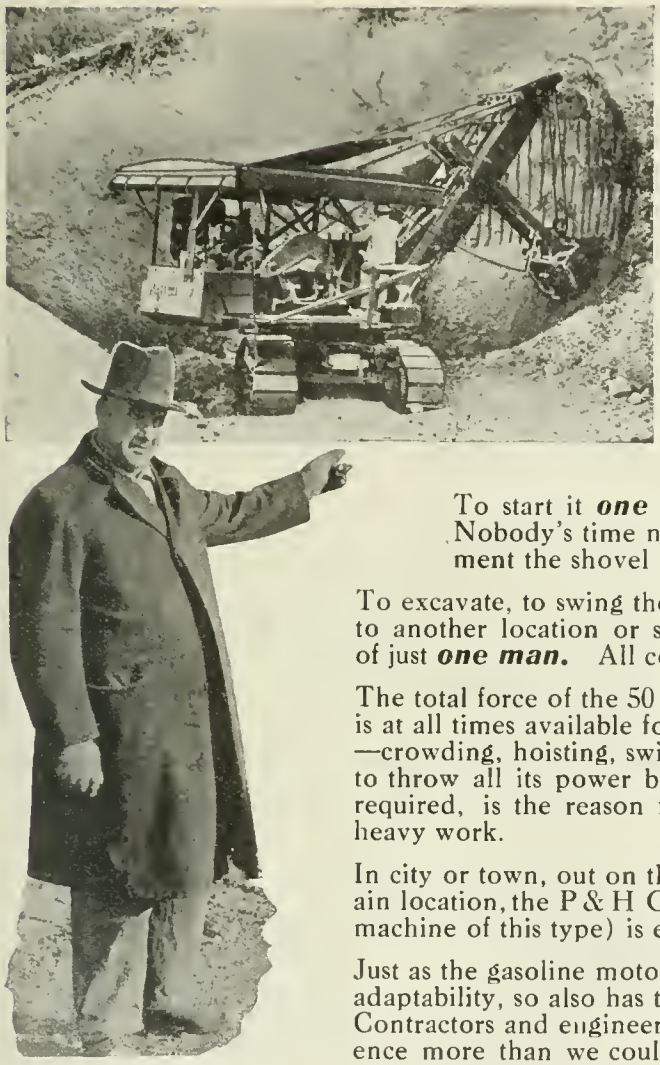

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The total force of the 50 h.p. motor (on the 206 machine) is at all times available for each of the shovel movements —crowding, hoisting, swinging and traveling. Being able to throw all its power behind each movement when so required, is the reason for its phenomenal capacity for heavy work.

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- *Uses 15 to 18 gals. of gasoline and 1 qt. oil in 8 hours.*
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- *Easy Mobility—Full Corduroy Traction.*
- *The One Gas Shovel with a Real Crowding Motion.*
- *Wide Adaptability.*
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Motor Truck Operation and Accounting—80

USE OF MOTOR VEHICLES BY NEW JERSEY STATE HIGHWAY DEPARTMENT

By N. C. Applegate, Equipment Division, New Jersey State Highway Commission, Trenton, N. J.

The State Highway Department of New Jersey has a total of 417 motor vehicles; that is, light cars and trucks, and in addition also has approximately 175 other pieces of power equipment, including rollers, tractors, concrete mixers, steam shovels, pumps, etc., under the direct control for care and operation of the Equipment Division.

The Equipment Division acts as a trucking or equipment contractor to the other State divisions, such as Maintenance, Construction, Bridge, etc., and has full charge of maintenance and care, and method of operation of equipment. The operators of these vehicles work under the supervision of the various superintendents, foremen and engineers, as to hours worked, and work done.

Installation

In reference to the installation of new types of equipment, this is a problem that we have not as yet had to go into very deeply. Practically the only installation in the last year has been the purchase of several one-ton trucks and survey cars, which trucks and cars cover a field by themselves in which no other type of equipment would be suitable. In reference to the installation of the larger type of equipment, all the heavier motor vehicles now in use by the Highway Department are war surplus material. In the distribution or assignment of these vehicles to the various jobs around the state, various local conditions such as amount of material, approximate haul, source of material, whether new construction or maintenance work, and approximate length of time vehicles will be used on that particular job are all taken into consideration.

Standardization

The question of standardization is another problem which does not immediately interest us, due to war surplus material on hand. When six or eight trucks are sent out to take care of a particular job, we endeavor to have all trucks of the same make and type in order to simplify the work of the mechanic in taking care of them. In reference to heavier trucks, we are now using fifteen different makes of trucks and six different makes of touring cars. As stated before, practically all equipment is war surplus material, which has been transferred to the state at nominal cost. However, on gravel maintenance work and patrol units we have practically standardized on one-ton trucks with the tilting hand-dump body.

The question of installation and standardization also becomes difficult, due to the fact that the work on the various jobs throughout the state is not constant. Irregular receipt of material by freight also handicaps us in selection of the type of motor equipment to be sent out on the job as the truck may be used to haul material for several days, and either lay idle, be used for cold patch work, or to transport laborers for several days while waiting for material.

Control

Locations of every piece of equipment are kept posted on a large map of the state showing the different highway routes. Different colored and sized map-tacks, with the various department numbers printed on them, are used to denote different types of equipment. These tacks are spotted on the map as near as possible to the actual place where equipment is located. The map which we use is on a scale of approximately one-half inch to one mile. This map is posted within two or three days after changes in location are made. A card system is also kept which gives full information regarding the piece of equipment, together with the dates the locations of same are changed.

Operation

In our work the season is about seven or eight months long and outside of a few isolated cases the truck would not be in one location on the average for more than three or four months. This makes it difficult to procure and keep competent drivers of the type required in industry. Practically every time that the location of a truck is changed it becomes necessary to change drivers, due to the fact that the older men object to working away from home, and the short season. Most of the drivers want all-the-year-round outside work and object to being placed in the shop throughout the winter season.

Vehicle Inspection

Our inspection was taken care of in the past year by one inspector who covered the entire state. He was able to make the trip once in two weeks. This inspector's duties were as follows: To inspect and make a report as to care of equipment and method of operation, and report same to the Equipment Office, also to make whatever minor adjustments were necessary. He did not, however, do any repair work on these trucks, but in cases where he found it necessary he would phone the central garage, Trenton, and a service mechanic with repair parts would be sent out to take care of the trouble. This year, on account of additional equipment in use, we are planning to divide the state into four districts, each of which would contain between 150 to 200 miles of state highway. One mechanic or, if necessary, one mechanic and helper, would be assigned to each one of these sections to make all necessary inspections and repairs on equipment. They would be held responsible for all equipment in their factory. Only in cases of extraordinary trouble such as serious motor or transmission trouble where it was necessary to bring the unit into the shop for repairs would the garage forces be required.

Repairs

We have one central repair shop which is located at Trenton. Practically any part of the State can be reached by a service man with parts necessary within three or four hours at the most from here. Sufficient stock is carried at our central service station to take care of all except extraordinary repairs, on all types fo equipment which we operate, except touring cars, on which we can get service at several different places in the State. While not actually working during the four or five months in the winter when they are taken off the road work, our trucks immediately after the road season are brought into the garage and equipped with snow plows and sent out and kept available at all times for snow removal. Up until the present season we have not had enough equipment "as reserve" to enable us to replace equipment out on snow removal, while these trucks were being overhauled.

Service

As stated in a previous paragraph, parts are carried in our service station for all makes of trucks. We have not found it practical to depend on Philadelphia or New York stock for truck repair parts as in several instances we have found it necessary to secure thes from factories located several hundred miles from Trenton.

Accounting

At present our accounting and costs are distributed in a general way as follows:

Operation of trucks. This menas that operating costs for all trucks are lumped together with no distinction made between different makes and sizes. In like manner all other equipment is lumped; that is, all costs for steam shovels, mixers, road rollers, pumps, etc., are grouped under the general head: "Operating of Equipment" and it is not possible to segregate different types and makes of equipment. It is my opinion that indlvidual costs should be distributed as follows:

Inside repairs
Outside repairs
Gas and oil
Tires
Operators' salaries
Operators' expenses.

The above should be compiled for eacb piece of equipment each month. This information is necessary for the intelligent working of eqlipment.

Tire Record

At present tires are furnished to us under competitive bidding. In the past very few tire records have been kept, due to the fact that the adjustments which we were able to get under the agreement under which the tires were bought, made the cost of keeping records of tires equal or more than actual benefits that we received from any adjustments.

I believe that transportation by motor vehicles offers one of the biggent fields for efficient organization.

The foregoing matter is from a discussion by Mr. Applegate before the recent annual meeting of the New Jersey State Highway Association.

MOTOR TRUCKS OPERATE ON RAILS IN CITY AND INTER-URBAN PASSENGER SERVICE

Again the motor truck steps into a new field and again it proves its versatility and adaptability beyond question.

For the first time in history, gasoline-propelled cars have been put into city railway service to replace electric trolley cars. This installation has been made by

A Great Truck Value

You will be greatly surprised to find how little more it takes to buy a Packard Truck than to get just an ordinary truck.

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Its certainty of performance, its economy of upkeep, and its security as an investment, all combine to make the Packard Truck at its present price the greatest value in the motor truck market today.

It is the product of a company that is known for stability and experience. Prompt service at the fairest of prices for labor and parts is available on it everywhere, through nation-wide Packard facilities.

In its daily operation, the Packard requires a minimum of routine care, and it always returns a maximum of powerful, dependable service.

It is a thoroughbred in design, materials, and workmanship. Its quality is the rugged quality essential for long life, freedom from trouble, and low-cost operation.

Have your Packard dealer quote you the figure at which the Packard Truck is selling today. He is ready to advise with you also on any special or body equipment you may require for the economical handling and hauling of your products.

In more than two hundred lines of business, Packard Trucks are relied on today for better hauling at lower cost.

Packard Trucks range in capacity from 2 to 7½ tons, and in price from $3,100 to $4,500, at Detroit

PACKARD

ASK THE MAN WHO OWNS ONE

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

the Manhattan City and Interurban Railway Company of Manhattan, Kansas, which recently scrapped their heavy electric cars and equipment and are now operating four FWD railway cars, manufactured by the Four Wheel Drive Auto Co. of Clintonville, Wisconsin.

A few years ago the idea of operating a motor truck on rails would have been laughed at, yet the chasses for these cars are the same as the chassis used in the standard FWD 3-ton truck with the exception of those changes which are necessary to fit the trucks for rail service. These cars are operating on the same rails over which the electric cars formerly operated and according to the same schedules.

The excessive cost of operating the heavy electric cars for a patronage which has decreased considerably since the war was the deciding reason which influenced officials of the Manhattan City and Interurban Railway Co. into buying lighter equipment. It cost them between 40 and 50 cts. per mile to operate electric cars and they give the public just as good service now at a cost of about 15 cts. per mile. But they gained more than ating a car instead of two; they elimisimply a reduction in operating costs by installing motor equipment; they reduced their number of employes, one man operated the expense involved in the operation of a power plant and three substations; they are able to operate their motor equipment with less noise and less annoyance to the public; they reduced their cost of maintaining their right of way, the new equipment being much lighter and less destructive to the rails than the heavy electric cars; they reduced the liability of damage suits resulting from accidents, which were quite frequent when the electric cars jumped the tracks. Besides all of these advantages, this company has done its bit toward beautifying Manhattan through the removal of overhead trolley wires and poles from the city streets.

Each car provides seating capacity for 32 persons and a space for baggage. The cars are well finished inside and afford great comfort to passengers. Some of the other features of the cars are as follows: 156-in. wheelbase; high speed reverse gears which enable the cars fo go as fast in reverse as they will go forward; locomotive type "cow-catchers"; electric starting and lighting devices; heating systems which utilize the heat from the motor exhaust; entrance and exit near

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AN ACCIDENT PROOF CAST STEEL
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A unit that is indestructible, and even more conspicuous at night than in the day time.
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The only cast steel unit on the market.
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the front of the car with the door operated by the driver. In addition to the rail cars they operate one bus on the highways between Junction City and Fort Riley as a feeder to their interurban line. This bus looks somewhat similar to the rail cars, having the same kind of body. The weight of the chassis in each case is 7,200 lbs., as compared to 60,000 lbs. which is the weight of the heavy and noisy electric cars.

The two cars operating on the city lines average about 95 miles each per day and 500 stops each per day, while the two cars in interurban service average 150 miles each per day and about 250 stops each.

Both in the city and on the interurban line between Manhattan and Junction City, there are many steep grades and sharp curves in the tracks. At one place the cars travel up a 5 per cent grade which is 2,500 ft. long, and another 3½ per cent grade which is 4,000 ft. long. The curves encountered by these cars vary from less than one degree up to a curve with only a 45-ft. radius.

When the first snow of the winter arrived at Manhattan, citizens were doubtful as to the ability of the cars to operate in the snow without the use of a snow plow, as had been the custom with the electric cars. But all doubt was cleared away when the trucks, with little difficulty, plowed through the deep snow which was drifted in places to a depth of 2 ft.

With the load equally distributed over the four wheels and with every wheel a driving wheel, these FWD trucks obtain a maximum amount of traction, which makes them particularly well adapted to service over steep grades, around sharp curves and over snow-covered rails such as they encounter in the service on the Manhattan lines.

Regarding the service given by their motor equipment and the cost of operating it, company officials state that the installation is a great success. They also state that not one complaint about the service with the new equipment has been received, which speaks pretty well for the patrons' satisfaction and which goes to prove that service is the secret of universal satisfaction.

ONE NEW YORK TOWNSHIP WILL LIGHT 100 MILES OF HIGHWAYS

By O. J. Helvey, Lighting Specialist, General Electric Co., Schenectady, N. Y.

The Township of Amherst, New York, which lies adjacent to Buffalo, has decided to illuminate all the highways within its borders, and has entered into a contract with the Buffalo General Electric Company for a lighting system for its entire road milage, a total of about 100 miles.

HIGHWAY BUS MAKES DIRECT CONNECTIONS WITH INTERURBAN CARS.

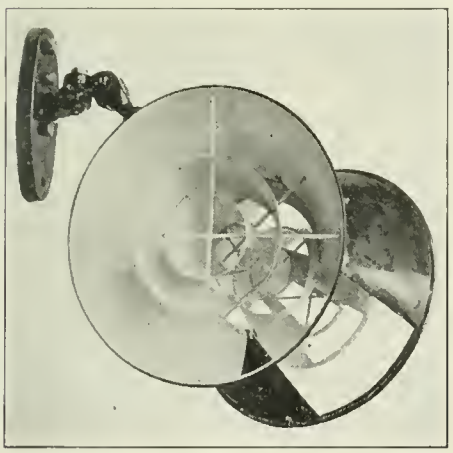
This is the first instance, so far as can be recalled, in which a township has decided to light all its roads.

The work will be spread through a period of three years, and the complete installation will consist of between 1,000 and 1,500 units, including those to be placed along the portion of the Buffalo-Niagara Falls boulevard which will be lighted jointly by the Buffalo General Electric Company and the Tonawanda Power Company.

The project is the result of a painstaking investigation made by the supervisor of the township, Mr. John Worley, of all the different methods of highway light-

ing. He made a trip to Swampscott, Mass., and to the Albany-Schenectady highway, where he could view installations of the new G-E highway lighting units in sufficient numbers to enable him to make an unbiased report to his constituents. He also had a few units installed on one of the main thoroughfares so that all who were interested could inspect them.

The contract between the township and the Buffalo General Electric Co., calls for the installation of 212 units at once, the others to be added as directed by the supervisor of the township. These first units will be placed along five miles of the great east-and-west highway leading eastward through the township from the Buffalo city line, one of the great motor travel routes of the United States, as well as along a number of parallel stretches of improved roads, and cross roads. Work on the main road installation, which was begun at the Buffalo city line, has already been started.



BRACKET TYPE SERIES HIGHWAY LIGHTING UNIT.

The G-E Novalux Highway Lighting unit will be employed. This unit has a parabolic nest reflector and embodies certain new features for collecting the light rays and directing them where most needed. Briefly described, it consists of two nests of three reflectors each, with a MAZDA lamp mounted in the center, and the filament at the focal point of both sets. By this arrangement the greater part of the light that otherwise would be lost by reflection upward and outward to the adjoining fields, is collected and cast in both directions on the surface of the roadway. The rays that would escape if only one reflector were used are picked up by the inner reflectors and directed towards the roadway at an angle of ten degrees below the horizontal. A single parabolic reflector would have to be approximately fifteen feet in diameter to give the same effect. The white reflecting surfaces of the unit reduce the glare.

Within this reflector is a 250-candlepower Mazda C series lamp, operating from a constant current circuit. By this arrangement a maximum of more than 4,000 candlepower is obtained from each end of the reflector from a lamp consuming only 153 watts. The bracket holding the unit is adjustable in either a horizontal or a vertical direction, thus making it possible to mount the fixture either on poles near to, or some distance from, the roadway, and to turn it so as to illuminate curves and hillsides.

These are the same type of units as those which have been installed at Swampscott, Massachusetts; along a stretch of the Albany-Schenectady highway; in the vicinity of Detroit, and along the Miami-Miami Beach (Florida) causeway, a thoroughfare over which an enormous amount of traffic passes. It is proposed to install them along the Ideal Section of the Lincoln Highway, in Lake County, Indiana, a section of roadway which will represent the very best highway construction that engineering talent can devise.

In the Amherst installation, the units to be placed along Main street will be spaced at intervals of approximately 400 ft., 30 ft. above the surface of the highway and about 20 ft. back from the shoulder of the road. On the less important highways, such as earth roads, etc., it is planned to space them 600 ft. apart, but the lamps will be of the same size and type—250-c.p. Mazda C. The units are to be operated on General Electric R. O. transformers, the transformers to be turned on and off by means of a time switch. The township will pay the Buffalo General Electric Company $60 per year per unit.

This installation—even considering only that portion of it which is planned for this year—not only is one of the largest yet authorized, but is of especial interest as being, so far as reported, the first instance in which a township has definitely committed itself to the proposition of lighting all its highways.

Why Road Builders Prefer Kentucky Rock Asphalt

Contractors and engineers who have laid or supervised Kentucky Rock Asphalt pavements prefer it to other hard surface types. The reason for this is evident when the advantages of this natural asphalt mix is understood and verified by experience.

Kentucky Rock Asphalt is ready mixed and ready to lay cold on any base adequate to carry the traffic. It is shipped in open top cars and may be unloaded and handled by machinery at a considerable saving. Kentucky Rock Asphalt is not susceptible to damage from the weather. The material may be ordered in at any time and stored in the open at convenient sites along the work, thereby eliminating costly delays.

No expensive equipment is required in Kentucky Rock Asphalt construction. Shovels, rakes and a roller are all the equipment needed. There is no need of skilled or expert asphalt workmen.

Kentucky Rock Asphalt requires no special binder course on curb. The material is spread cold on the base; raked to proper depth and rolled. The pavement may be thrown open to traffic immediately.

Kentucky Rock Asphalt has eliminated the risk of surface failures or replacements. Every contractor knows that in laying the more common types of asphalts, he constantly faces the risk due to human error in mixing, heating or laying. Kentucky Rock Asphalt is uniform, by laboratory test. Exposure to the elements, even for a period of years, does not affect it. Laid on a base sufficient for the traffic, it always gives maximum results.

Foundation replacement is not difficult even after the surface has been laid. The rock asphalt may be cut away and, after the base has been repaired, the asphalt may be broken up and used again in restoring the surface.

Surface irregularities may be corrected without disturbing the pavement. If a slight depression occurs in the finished job, the surface may be roughened and brought to proper grade by adding rock asphalt. The patch, after a few days' traffic, will bond so perfectly that it may not be detected.

The finished Kentucky Rock Asphalt surface is equal in every respect and in many ways superior to sheet asphalt. It is smooth, noiseless, dustless and resilient. Kentucky Rock Asphalt pavements do not crack, roll, buckle or bleed even under the most severe traffic and climatic conditions.

Kentucky Rock Asphalt has been recognized in the standard specifications of ten states. It has been approved for Federal aid on such heavy traffic roads as the Dixie, Jackson and Lincoln Highways and the National Road.

If you are a contractor, anxious to get away from costly equipment and many uncertainties of road and street construction, or if you are an engineer eager to serve your community by building the best pavement at a reasonable cost, it will pay you to investigate Kentucky Rock Asphalt. Write for Booklet E.

Kentucky Rock Asphalt Company

INCORPORATED

711-718 Marion E. Taylor Building LOUISVILLE, KENTUCKY

EDITORIALS

INTERPRETING RESULTS OBTAINED ON TEST ROADS

Everyone has recognized the need for impartial, scientific investigations of the carrying capacities and wearing qualities of various types of paved highways under modern traffic. Some elaborate experiments have been made and results are beginning to appear. We are in complete accord with the objects of these tests and have confidence in the ability and integrity of the men in charge. Therefore, it is furthest from our purpose to say anything which will detract from the value of this much-needed experimental work. But we do wish to suggest a proper degree of conservative caution in adopting test results and applying them in designing new roads.

It is exceedingly difficult to evaluate all factors in a highway engineering problem. Oftentimes assumptions must be made before a mathematical treatment is possible and these assumptions are likely to be highly erroneous. We would suggest, therefore, that engineers in interpreting test data look sharply to distinguish between conclusions based on hard facts, from which all uncertainties have been eliminated, and conclusions based on mathematical discusslons resting in part on assumptions. The very object of these tests is to obtain facts which are free from the uncertainties born of assumptions, but we fear assumptions will find a way of creeping in unless vigilance is exercised in excluding them.

DIFFICULT DAYS FOR ENGINEERING SOCIETIES

Many engineering societies are now passing through the most difficult days they have ever experienced; they have suffered a loss of income at the same time their operating expenses have been at a maximum. It is not strange that they are hard pressed to make ends meet. The gravity of the situation may be appreciated from the fact that one old, well-established society reports that its members are well in excess of ten thousand dollars in arrears in their dues. This has forced the society to borrow money to pay operating expenses. Another old society has been asking its members to pay dues for the next year within the present year and has managed in this way to pay its present bills; what it will do in another year is not yet clear. At least one society has adopted a method of collecting back dues which will subject it to much adverse criticism unless the profession takes a charitable view of the matter, due to the unprecedented difficulties with which the officers of the society have been, and are still, confronted.

During the boom times of a couple of years ago some societies put on elaborate membership drives and succeeded in putting on a great many new members, thereby greatly increasing operating expenses. With the coming on of harder times, society dues have seemed to come around pretty often and have become increasingly difficult to pay, especially to men who belong to several societies. Many engineers have had their salaries cut and others have been out of employment for considerable periods; many in business for themselves have operated at very small profits and doubtless some have lost money. In view of these facts it is not hard to see why so many society members are in arrears in the payment of their dues. Meanwhile operating expenses have been very high, notably in the printing of proceedings. The result of decreased income, accompanied by increased expenses, has been the placing of a very heavy burden on the officers of many societies.

We bespeak for these officers the support of the profession. They need assistance and not criticism. Their tasks, always difficult, will now prove impossible unless they are supported in every way by the profession.

"SOFT" CITY WATER

Great interest has been expressed by readers in the symposium on the centralized softening of a public water supply published in the March issue of this magazine. The present issue continues the discussion. The topic is one of economic

importance and of timely interest. After being very quiet for several years, water departments and water companies are beginning to take a lively interest in improving their plants and their product. Many are inclined to the belief that the time is near at hand, if it is not already here, when water utilities will no longer be satisfied with their product, however palatable and pure it may be, if it is too hard, as drawn from the tap, for agreeable use in the home and for economic use in industry. The effect of hard water on health is a subject on which general agreement has not been reached, but all are agreed that a hard water is an expensive and troublesome water to use.

Many plants, fortunately for them, are not troubled with this question at all, for they have supplies which do not require softening. Many others, however, have supplies that are hard and many plants are distributing water which should be softened. In general, we believe, and expert opinion seems to support this belief, that it is more economical to soften such a supply at a central plant before it is distributed than in the home and factory after it is distributed. By softening in the home we do not refer especially to the use of household water-softening plants, but to the use of softening powders, hard water soaps, etc. It is unquestionably more expensive to use a hard water than a soft one, whether in the home or in industry, and our advocacy of the centralized softening of an entire supply is based on the belief that water takers can pay more for a softened water than for a hard one and save money by doing so.

The terms hard and soft are, of course, relative. We are not here concerned with definitions; limits have been fixed in the discussions to which we have referred. It is not the purpose of the present discussion to enumerate all the arguments in favor of water softening; those have been well stated by contributors in our Water Works Section. Our present purpose is to urge all water utilities now distributing a hard water to investigate the economic feasibility of softening it at a central plant. The art has been developing for some years and has advanced to the point where experts do not hesitate to recommend centralized softening. It should be understood that where a water utility undertakes this new function it should be adequately compensated for doing so in the form of increased rates.

Space will be devoted to this subject in future issues of this magazine. We are interested in the advancement of knowledge with respect to the subject and this requires the statement of negative, as well as affirmative, views, if, indeed, there are negative views. We wish to present all shades of opinion which are sincerely held by our readers.

AN ENGINEER ON INFLUENZA

In this issue we publish the first in a series of two articles entitled: "Municipal Sanitary Precautions During Epidemic of Influenza." The first article discusses the general aspects of the disease and its epidemics and pandemics. The second article will give detailed recommendations as to measures of public hygiene and sanitation to be instituted by municipalities in coping successfully with this dreaded disease. Those who remember the scourge of this disease in 1918, when people died so fast, in some localities, that they could not be promptly buried, even when graves were made with steam shovels, will not need to be urged to study and preserve these articles for use in the future. Appalling as the thought is, there is every reason to believe that epidemics of this disease will come again, as they have been doing from time to time in past centuries. It is very difficult to prevent the spread of infection; for this reason precautions and preventive measures should be enforced at the very first sign of the appearance of the illness. Here is a case calling for preparedness quite as much as in national defense against a foreign enemy, for influenza may be more dangerous to a nation than any foreign foe, for it does not recognize noncombatants and even the helpless must offer such resistance to it as they can muster.

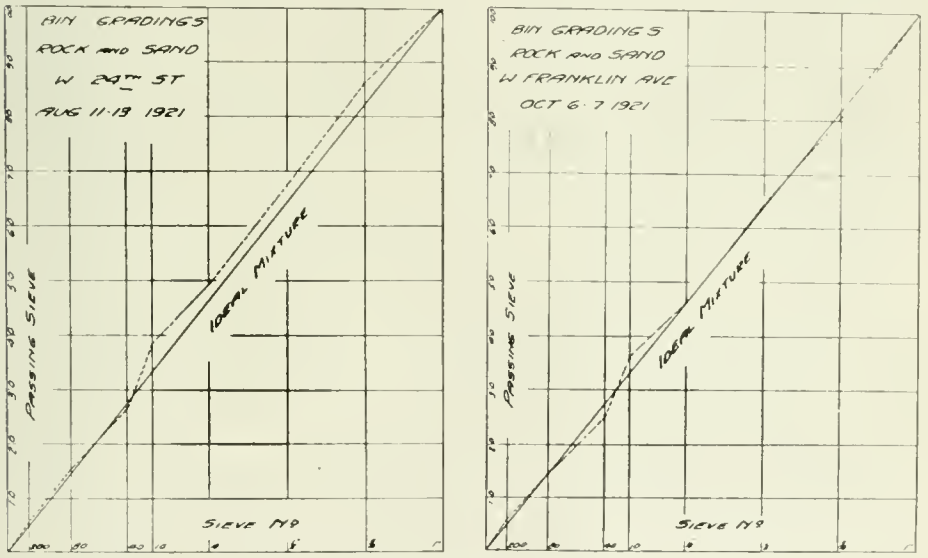
Our contributor comments on the fact that it is astonishing, in view of the fact that epidemics and pandemics of influenza have been occurring for centuries, that the medical profession, with a few exceptions, should not be better prepared to contend successfully with the disease. We are glad to see an eminent engineer turning his attention to the subject.

The editor cannot pretend to have anything remotely approaching expert knowledge on this subject, but he has observed that competent osteopaths have been wonderfully successful in treating influenza cases. We suggest that the individual reader satisfy himself on this point.

CONTROL OF ASPHALTIC CONCRETE MIXES

By Ellis R. Dutton, Asst. City Engineer, City Hall, Minneapolis, Minn.

One of the most essential things about the operation of an asphalt plant is to have an adequate and reliable control of all the material that enters into the mixture. In order to obtain this control it is primarily necessary to know beforehand the proper proportion of the various ingredients that make up the best mixture for the purpose intended. That means that the best available materials in the locality shall be tested in the laboratory by competent men to determine the proportion of each size of the coarse and fine aggregate corresponding to the screens of the asphalt plant which shall be used to make the most dense mixture.



DIAGRAMS ILLUSTRATING MINNEAPOLIS METHOD OF CONTROLLING ASPHALTIC CONCRETE MIXES.

In the ordinary asphalt-concrete plant there are at least three separations of the coarse aggregate and the laboratory determination should be made along these separations. In the present practice in coarse aggregate bituminous concrete the larger particles are those passing a 1-in. screen, and in some cases 1¼-in., but the tendency is toward the smaller size or even smaller. With this larger aggregate there is combined proportions of the other two separations to produce a mixture of the smallest percentage of voids, at least as low as 20 per cent. This is to be filled, and perhaps a little in excess, with the finer aggregate conforming to the standard street asphalt grading.

Having determined this proportion definitely a rectangle is constructed and one perpendicular is divided proportionally into percentages "passing sieve" up to 100. A diagonal line is then drawn from zero to the opposite corner of the rectangle. The other perpendicular is assumed for the largest graded aggregate and lines are drawn from the proper percentage points for the remaining aggregates on the diagonal perpendicular to the base. This will give a definite line for an ideal mixture.

By platting the results obtained from the analysis of the samples it will be indicated diagramatically what variation there may be from the ideal grading and will enable the operator to make such changes in the mixture as will nearly conform to the ideal grading. The idea for these control curves was suggested in Bulletin No. 22, Texas Experiment Station, by Roy M. Green, Assistant Professor of Highway Engineering, and has been worked out by Mr. E. T. Davies, Chemical Engineer for Minneapolis, and E. F. Campbell, Superintendent of Asphalt Construction.

Two diagrams from the records of the Minneapolis Asphalt Plant which show the advantages of this method of control are presented herewith.

The percentage of voids in these mixtures runs from 17 to 18 per cent and the specific gravity of the compressed pave-

ment was about 2.54. The pavement cost, for the top complete laid, about $1.10 average per square yard, 2-in. thick, paying $5 per eight hours common labor and special labor in proportion, $3.65 per ton for trap rock, $1.50 for sand, $2.15 for screenings, $27.45 for asphaltic-cement, $12 for coal and $5.25 for limestone dust.

THE EFFECT OF SOIL MOISTURE ON HIGHWAY DESIGN

By J. L. Harrison, Civil Engineer, East Falls Church, Virginia.

Perhaps the most natural approach to a consideration of the effect of soil moisture on highway design may be had by examining, for a moment, the question as to what is the normal behavior of moisture in the soil. This can be done by noting the factors entering into the normal behavior of soil moisture as the engineer must deal with this moisture. These are, first, the almost universal presence of a body of saturated soil generally but a short distance below the surface of the ground; second, steady evaporation of moisture at the surface of the ground and, third, a constant flow of water from the saturated soil to the surface under the influence of capillary attraction.

The Capillary Flow

A stratum of saturated soil not far below the surface exists in all fertile sections of this country and in most arid sections. The depth below the surface at which this stratum lies (that is, the position of the water table) varies greatly. After long continued heavy rains the water table is generally closer to the surface than after long dry periods. Generally speaking it is closer to the surface on low ground than it is in rolling country or on high land. Also it is generally closer to the surface in dense soil through which the sub-surface drainage is poor than it is in open soil where sub-surface drainage is relatively good. Other conditions too numerous to mention here, affect the level of the water table. The fact may, however, be accepted that a body of completely saturated soil lies at no great distance below the surface in practically all regions where roads are built. From this body of ground-water capillary attraction causes steady upward flow toward the surface. If the rate of evaporation exceeds the rate of this capillary flow the surface of the ground appears dry. If not, it is moist. In any event, whether the surface is dry or moist this steady flow of moisture persists.

Capillary Saturation

We come, therefore, quite naturally to the first and probably the most important relationship that exists between the highway and soil moisture, namely, the fact that all of the higher types of pavement are of such density of surface that evaporation through them is always obstructed and often impossible. Underlying the highway surface there is, of course, the same water table that exists in other places and between that and the pavement, a layer of soil through which capillary attraction is constantly moving water to the surface where, under normal conditions, it would be evaporated. But the highway surface interferes with and often entirely stops evaporation with the result that the soil underlying the surface accumulates the water brought up by capillary attraction until it attains a condition of approximate capillary saturation. This condition is surprisingly constant throughout the year. There are, of course, variations due to a number of causes but generally these variations are relatively small. Thus, in long continued dry weather the moist soil under a pavement may become a secondary source from which moisture is drawn to the shoulders by lateral capillary action. During extreme drought this action may reduce the moisture content under a pavement almost as far as it is reduced in the shoulders. However, such an extreme condition is by no means of frequent occurrence. The more common condition, and the one generally found over the eastern half of the United States, is that in which the soil under the pavement is kept at or near the point of capillary saturation, for the rate of vertical capillary movement is enough higher than the horizontal rate to maintain a high moisture content even during rather extended dry periods.

The amount of moisture that capillary attraction will hold in the soil varies considerably with the nature of the soil. It may be so little as to be of no particular importance. This is the case with gravels and sands that contain no clay. On the other hand, the amount of moisture held by capillary action may be considerable, often reaching and sometimes exceeding 40 per cent in heavy soils. In the latter case the amount of water present is quite sufficient to render the soil plastic like soft putty. Between these two extremes with a marked tendency to approach the latter lie the vast majority of the soils encountered in road building. It is therefore a safe statement that capillary attraction will hold enough mois-

ture in practically all of the soils ordinarily encountered in road building to render them pliable—that is, of a consistency varying from soft putty to hard putty—and that this is their normal condition during the greater part of the year.

Capillary Moisture not Gravitational

Nor is there any way of avoiding this for this moisture is not gravitational; that is, it does not move under the laws of gravitation. Therefore it is quite impossible to relieve the situation by the placement of tile or other forms of drainage. Tile drainage could, in the opinion of the writer, be advantageously used more often than it is, but even where tile drainage is used it cannot reasonably be expected that the load supporting capacity of the soil will be permanently held above whatever capacity the soil may have when saturated to the extent of its capillary capacity. This has led to more or less disappointment where tile drains have been used but it is not so much an argument against tile drainage as against the presumption, too often expressed, that the use of tile drainage will insure a firm, stable sub-grade.

Supporting Power of the Sub-Grade

This view of the matter also has a bearing on another phase of highway design. It has been customary to think of the sub-grade under a pavement as dry. Almost everyone is familiar with the load carrying capacity of relatively dry soils as illustrated by their behavior in what are popularly known as earth roads. Coupling our ordinary everyday knowledge of the carrying capacity of such roads when dry with the ordinary conception of a dry sub-grade, has resulted in assumption that an ordinary highway sub-grade has a high load supporting value. As a matter of fact, this is not the case. On the other hand, it is very difficult to say just what the normal supporting power of a highway sub-grade really is. It is a relatively simple matter to determine the theoretical supporting power of any soil on the basis of a given moisture content, under laboratory conditions and this is, of course, valuable work. On the other hand, it does not by any means solve the problem for we are in possession of practical illustrations of the fact that higher loads than those indicated by laboratory experiments can be carried under field conditions. For instance ,the load on the sub-grade that is caused by a heavy engine moving at a high rate of speed greatly exceeds the loads generated by the ordinary forms of highway traffic and exceeds the theoretical supporting power of moist soils as developed by laboratory test. Yet neither the railroads using light ballast or those heavily ballasted are required to stop their train service on account of even protracted rainfalls at which times the moisture content of the soil, immediately underlying the ballast, undoubtedly exceeds anything capillary action could hold in the soil under a highway pavement. It is true that there is some distortion immediately under the loads as the trains move over the track and it is highly probable that this distortion extends into the sub-grade but, in practice, this does not work to the great detriment of the track, largely because of the facility with which track can be realigned if unduly distorted. On the other hand, the conception of a moist yielding sub-grade as distinguished from the more ordinary conception of a dry and unyielding sub-grade should tend to encourage the construction of deeper pavements in order thereby to distribute the load on the sub-grade more in conformity with the carrying capacity of the sub-grade. This is bound to have a marked effect on gravel and macadam design and should, the writer believes, also have a bearing on the design of pavements of the rigid types, for pavements cannot be readily realigned when once distorted.

The above general statement has been drawn to depict the simplest possible conditions that can occur in the soil. It may, therefore, be well to note that, though the general result is not thereby affected, the actual conditions prevailing are not quite as simple as the above statement might make it appear. The actual movement of moisture to the surface is more apt to be from secondary bodies of partially saturated soil lying above the water table than from the water table itself. Moreover, from time to time rain falls and is absorbed by the soil on which it falls. Its downward movement is partly gravitational and partly by capillary action. Long continued rains not only raise the water table but increase the amount of water held in the soil which overlies the water table, bring it, in fact, to a point of complete capillary saturation. This merely acts to affect the rate of capillary flow, but it does not otherwise modify the general processes going on in the soil. It has, therefore, little effect on the moisture conditions under the pavement because, for reasons outlined above, the soil under a pavement is at or near the point

of capillary saturation in any event. This has been mentioned, however, because besides alluding to the more complicated processes governing, it offers a complete explanation of the fact that the spring and summer rains seldom affect the stability of pavements even though of unusual duration, the simple reason being that as it is already in a condition approximating capillary saturation, the storm water moves downward without modifying the moisture content of the sub-grade.

The Early Spring Sub-Grade Condition

One other condition of common occurrence may well be mentioned. This is the early spring sub-grade condition which results in so many pavement failures. The causes are quite as simple as those outlined above and quite as uncontrollable. Briefly, it is recognized by all engineers that the load supporting power of soils falls off rapidly as water is added. If the amount of water exceeds that which is controlled by capillary action, the lack of stability becomes very marked. For this reason, tile drainage must be resorted to whenever there is any danger that the ground water may rise to a point of undue proximity to the pavement. Just what the minimum separation should be will depend on such questions as the stability of the saturated soil, the loads to be carried, the smoothness of the pavement, etc., but whatever solution is adopted in any given case, the necessity for this separation is recognized by all highway engineers and whenever there is danger that the water table will approach too close to the pavement, tile or other drainage is freely used.

But there are large sections of the country where, during the winter, the soil is frozen to a depth often amounting to a number of feet. After the spring thaws begin it is often a month or more before the frozen layer completely disappears. This is a condition well recognized by drainage engineers—particularly those familiar with the tile drainage of farms—as it has a definite bearing on the functioning of such systems and on the unwatering of farms in the early spring.

But during the period when the surface of the ground is thawed out but before the frost has left the ground, such moisture as falls is absorbed in the surface layer that is free from frost, for it, of course, cannot penetrate the still frozen stratum. The result is a complete saturation of the soil on the immediate surface of the ground with such loss of stability that in walking over fields one sinks appreciably into the soil. This condition is so common an occurrence in the early spring that everyone has experienced it repeatedly. If the rainfall at this period is considerable, the condition will persist until as much as a foot of soil has been thawed out but thereafter it gradually disappears as the rainfall at this time of the year is seldom sufficient to completely saturate more than this amount of soil.

The result of all of this, so far as the ordinary pavement is concerned, is to produce a condition of instability identical with that which exists when the water table rises to or above the bottom of the pavement. Indeed, the spring thaw often actually does produce a secondary water table an inch or two below the surface of the ground as may be determined by digging a small hole to the frozen ground. If a water table exists the hole will partially fill with water, which such a hole will often do. This condition affects the stability of highways whenever it persists for a considerable period and the amount of rainfall during this period is sufficient to maintain a secondary water table at or just below the bottom of the pavement. In such cases the result is very similar to what every highway engineer would expect if the primary water table rose to the bottom of the pavement —distortion, ruts, and areas of rapid failure.

No Solution Is Obvious

It is always unfortunate to have to present unpleasant facts with no offer of a solution for the difficulties that these facts represent. However, no solution is obvious. Of course a recognition of the fact that the bearing power of the soils under modern pavements is less than has been supposed—in short, that for them the "dry" sub-grade is non-existent—will ultimately lead to the use of deeper surfacing in order thereby to better distribute the load. It is interesting to note in this connection that the deep pavements of Massachusetts and Rhode Island have given remarkably good service, no doubt for this reason. But such pavements are expensive and so there is a tendency to avoid them if possible.

The Thick Pavement

Deep pavements also suffer less during the spring thaws than do shallow pavements. Rains during the spring thaw often saturate the top 6 ins. of the ground, they sometimes saturate the first 12 ins., but there is less and less likelihood of complete saturation under the pavement

as the depth of the pavement increases. Deep pavements are, therefore, the most obvious solution of this problem. Other solutions may present themselves and laboratory experiments may develop new methods of treating sub-grades that will reduce the baleful effect of moisture, but of one thing the highway engineer may be absolutely certain—namely, that tile drainage never has and never will solve these difficulties, for the water that keeps the sub-grade wet in summer is moved by capillary action and so is not influenced by the presence of tile drains and that which assists in the ruination of pavements during the spring thaws is completely cut off from any tile drainage system by an intervening layer of frozen ground.

CONSTRUCTING THE TURKEY CREEK SEWER IN KANSAS CITY, MISSOURI

By Paul A. Hartung, Mem. Am. Soc. C. E., Engineer of Sewers, City Hall, Kansas City, Mo.

Kansas City, Missouri, is now engaged in the construction of what is known as the "Turkey Creek Sewer," which will provide against flood water menace to the vast terminals and industries lying in the western portion of Kansas City, not only from the Kansas River but also from Turkey Creek.

Turkey Creek, long a menace to shipping and other industries, including Kansas City's Stock Yards, has its source in Johnston County, Kansas, and flows in a generally northeasterly direction through Rosedale, Kansas, into Kansas City, Missouri, thence back again into Kansas City, Kansas, and discharges into the Kansas River at a point two miles from where this stream becomes confluent with the Missouri River.

Turkey Creek is a small stream, and serves a narrow valley approximately one-half mile wide. Its alignment is very tortuous, with a gradient of 40 ft. per mile. It is subject to frequent cloudbursts, which concentrating rapidly discharges approximately 20,000 cu. ft. per second.

After reaching Rosedale it is obstructed by numerous railroad trestles and bridges for streets which cause it to leave its channel and destroy traffic and industry; water has been known to rise to a height of 16 ft. at 28th Street and Southwest Boulevard.

The World's Largest Sewer

The Main Sewer is the largest, in the writer's knowledge, ever constructed on this continent or abroad, the main section being twin boxes each 17 ft. in width by 18 ft. in height, the overall dimensions being 39½ ft. in width and 23½ ft. in height, containing 13.5 cu. yds. of concrete and 1,975 lbs. of steel per lineal foot, the average cut from the surface to subgrade being 40 ft., gradient 0.20 and having a discharge of approximately 1,000,000 g.p.m.

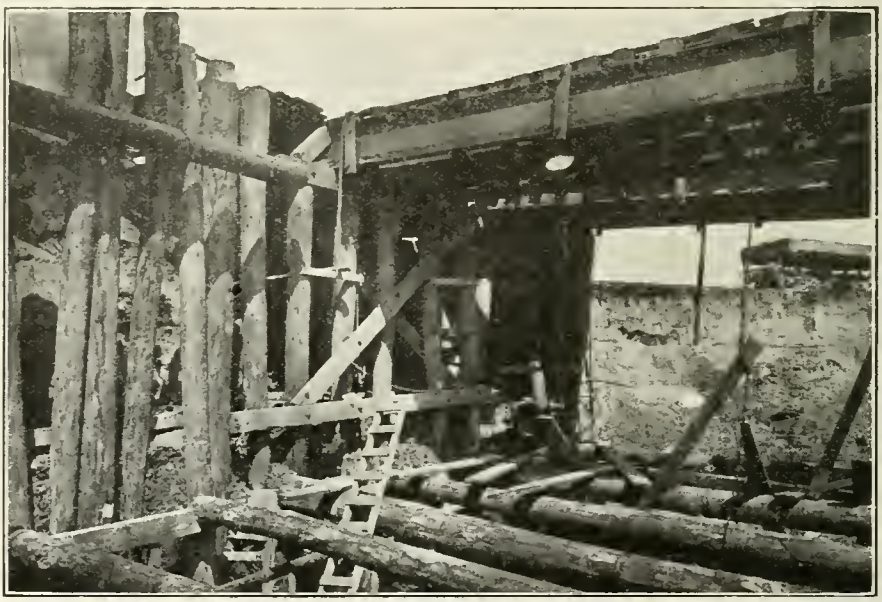
The Main Sewer is being constructed to withstand an internal pressure of 9 lbs. per sq. in. and receives all tributary sewers having their source above an elevation of 35 ft. (Kansas City, Missouri, datum), the same being the top of the dike of the

VIEW OF COMPLETED OUTFALL STRUCTURE, SHOWING SEWER APRON IN FOREGROUND, TURKEY CREEK SEWER, KANSAS CITY, MO.

Kansas River, and comprises the following sections:

17x18 ft. Twin Box, 1,750 lin. ft.
15 ft. 8 ins.x16 ft. Twin Box, 495 lin. ft.
12 ft. 10 ins. Horseshoe Section, 2,340 lin .ft.
11 ft. 4 ins. Horseshoe Section, 1,384 lin. ft.
8 ft. 10 ins. Horseshoe Section, 1,297 lin. ft.
7 ft. 10 ins. Horseshoe Section, 1,017 lin, ft., and various others ranging from 78 ins. to 30 ins.

The low level sewers comprise all sizes of Vitrified Clay Pipe and Monolithic Concrete from 8-in. to 30-in., and are served by two pumping stations which during high water stage discharge into the Main Sewer.



VIEW SHOWING METHOD OF BRACING WHEN PASSING UNDER RAILROAD TRACKS ON TURKEY CREEK SEWER CONSTRUCTION.

Sewage Pumps

The Pumping Station at 25th Street will be equipped with two 30-in. vertical volute double suction centrifugal pumps with a capacity of 30,000 g.p.m. against a head of 30 ft. and two 30-in. horizontal volute double suction centrifugal pumps with a capacity of 30,000 g.p.m. against a head of 15 ft., these pumps to be driven by two 300 hp. vertical slip ring motors at 450 r.p.m. and two 150 hp. horizontal slip ring motors at 400 r.p.m.

The Southwest Boulevard Pumping Station will be equipped with two 30-in. vertical volute double suction centrifugal pumps, having a capacity of 30,000 g.p.m. against a head of 30 ft, these pumps to be driven by two 300 hp. vertical slip ring motors at 450 r.p.m.; both stations contain smaller pumps.

The total length of sewers of all sizes constructed under this project include the Main Sewer of 8,283 lin. ft. and Lateral Sewers of 21,358 lin. ft., or a total of 5.55 miles.

The location of this project (a large portion of the same being built within the old channel of Turkey Creek, and its vast proportions, makes the construction of the sewers at times extremely hazardous and expensive.

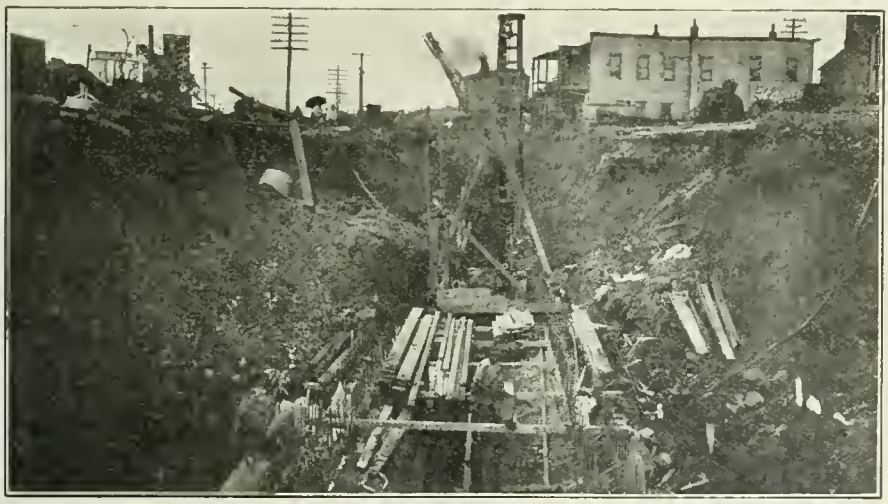
Construction Difficulties

At the time of construction of a portion of the 7-ft. sewer lying in the old bed of Turkey Creek, a proper foundation could not be found for a depth of 17 ft. Piling was resorted to and after placing the same in leads an ordinary steam hammer was allowed to rest upon the pile, the weight alone causing a penetration of 17 ft. without a blow. The piling was then driven through 3 ft. of hardpan to solid rock, but the slime and mushy condition of subgrade would not allow the placing of steel and certainly would not sustain the weight of concrete footing. To overcome this condition, a double course of 2x12-in. lumber grillage was laid and fitted in between the piling at cutoff,

both courses placed diagonally across trench. After the concrete had been poured instrumental tests were made for settlement, but none was found in any case.

This method was followed in a portion of the 4 ft. 4 in. sewer until the Penn Lubric Company's plant on the Southwest Boulevard was reached, where it was found to be impossible to drive piling on account of the location of Switch Towers adjacent to the sewer, as any settlement due to driving piles would have placed

From Station 0+00 (the beginning of the Main Sewer Twin Box) to Station 13+00, foundation was found in a course of dry sand, but at this point the water plane of Turkey Creek was encountered and while an excellent foundation was found, the sand disappeared and a tough gumbo saturated with water (but underlaid with a strata of coarse sand 2 ft. below subgrade) which workmen soon transformed into a loblolly. It was found necessary to resort to one course of 2x12-in. grillage for reasons before mentioned.



VIEW SHOWING SECTION OF INVERT AND PILE DRIVING IN 11 FT. 4 IN. SECTION OF TURKEY CREEK SEWER, KANSAS CITY, MO.

them out of commission; therefore a new method had to be adopted. Accordingly the muck and sediment which had been accumulating for years in the bed of Turkey Creek was excavated to the depth of 2 ft. below subgrade, which was later filled with large rubble stone. This had a tendency to press the muck up through the interstices as the large rock settled. When this course came to rest a course of small crushed stone was used to fill the interstices upon which the footing was poured. (Instrumental tests have not shown settlement.) In addition to the steel shown upon the plans, four railroad rail at 60 lbs. were placed longitudinally with lap points at 25 ft.

When better foundation was found the course of rubble stone was discontinued and a single course grillage was used, the same being necessary to prevent the steel from becoming coated with mud and also to prevent concrete from sinking into and becoming mixed with the mud. In other words, this portion of the sewer is laid upon a plank floor.

The Main Sewer in traversing its total distance intersects and crosses under 36 railroad tracks. The railroads, to further progress in the construction, have abandoned some of the tracks temporarily. These are chiefly industrial tracks. But where main lines were crossed it was found to be expensive and hazardous, many ingenious methods of bracing being used. Where it became necessary to maintain traffic upon main line tracks, piling 60 ft. in length were first driven on a line with the outside dimensions of the sewer, spaced 3 ft. on centers. These were capped and three 24-In. I beams 60 ft. in length were bolted together and placed under each rail. As the excavation proceeded downward, 12x12-in. whaling were placed along the piling, and piling 40 ft. in length were used as shores. These braces were placed on 12-ft. centers (vertically) but with this care some of the piling were fractured and allowed many serious cave-ins. Excavations are being made with drag line and clamshell, and

placed in cars and deposited as back-fill upon the completed structure.

The "Blaw" Steel Forms both inside and outside have been used exclusively in the construction of the Main Sewer.

Concrete is being mixed in the proportion of 1-2-4 (Class "A") using 40 lbs. of Hydrated Lime per cubic yard, and is deposited in chutes from a movable tower erected upon a specially constructed carriage containing two 1-yd. mixers, sand and stone hoppers, which are kept filled with material (which is deposited near the mixing plant) by the use of a clam-shell.

Where the Main Sewer discharges into the Kansas River a special outfall is being constructed at a cost of $125,000. This is built upon piling at 4 ft. on centers, driven to rock, at such an elevation below the bed of the river as to prevent erosion.

The contract for this work was awarded Thomas Kelly & Sons, of Winnipeg, Canada, (later changed to Kelly-Dennis Co.) in August, 1919, but owing to financial and bonding conditions at that time (surety bond being in the sum of $1,000,000) active work was not commenced until October, 1920. The work has been so prosecuted that at this time 60 per cent has been completed and with favorable weather conditions, should be completed in November, 1922.

The total cost of work will be $2,500,000, payable at completion in Special Tax Bills issued against property embraced within a Joint Sewer District covering an area of 5,000 acres and containing some of the most valuable property in Kansas City, Missouri.

SUBURBAN PLANNING

Charles F. Mebus, Consulting Engineer, 1512 Land Title Bldg., Philadelphia, Pa.

Much has been said and written about Town Planning and a great deal has been accomplished in the larger cities where the engineering departments are in charge of men of high attainments, and where the city council or commission usually is wide awake and anxious to make its own city as fine as possible.

Evils of Unrestricted Planning

But beyond the limits of the larger city lies, in a sense, the great unknown, where the real estate operator, the country surveyor, or owner of a tract of land, which has become too valuable to be farmed profitably, may without any restrictions, subdivide a tract into building lots and offer them for sale to the unsuspecting buyer under the alluring terms of "$10 down and $1 a week secures your lot." This vacant lot game which was, in the east, before the war, at a very low ebb, suddenly sprang up again through the shortage of houses and the further fact that many people had money as never before, so plots were "cut up" and sold by the thousands in 1919 and 1920.

Large industries must often change their location to the country to expand properly, or to obtain sufficient ground to construct more modern shops, thereby necessitating the formation of new communities; again, new lines of transportation and the paving of main lines of highway, make it possible for those working or doing business in the city to live farther out. So a little money, the good roads and the cheap automobiles have, during the past few years been a wonderful asset to the vacant lot promoter.

The more intelligent person often considers the thing a good joke and laughs at the poor dupe who has invested in a piece of ground that fronts on a street which it is possible to find only by the aid of the corner sign post and long rows of lot stakes on either side; where there is no established grade; no restricted building line or any other restrictions. So houses may be built of anything, anywhere, and at any height with reference to the surface of the ground. Surely, this is a "free country"—no restrictions.

The so-called "land developer" thinks of but two things, viz: the largest possible number of lots he can carve out of his tract and the cheapest and quickest way to pass the lots on to the buyer. The future problems of the municipality, which are in this way created, are entirely ignored, for the "developer" holds but a minor interest and is working new fields by the time the municipal troubles of his customers and their successors become serious.

What Comes After the Inept Town Planner?

As the number of lots built upon become more numerous, the necessity for municipal improvements increases, and generally a new municipal unit is created or the limits of the adjoining one are extended to include the new development. Then the troubles begin, for the municipal authorities are confronted with making the best of a bad job. Street grades must be established, regardless of the fact that some houses will be left up high and dry, and others way down in the hole. A system of surface water drainage becomes

necessary, but the ravine goes through some fellow's front or side yard and he wants it taken somewhere else, no matter where, only so it costs him nothing and inconveniences him not at all. Sanitary sewers must be installed, but as system of street grades were not established in advance, deep and expensive sewer excavations are necessary to drain to a common point, which as like as not has no ground available for a sewage disposal. Surely the streets need paving—for what use is an automobile without paved streets, but my constituent who has strained every nerve to buy a lot, erect a bungalow with garage and buy an automobile is about "all in" financially and cannot conceive why he should pay his share of the municipal improvements, which he demands, on the per front foot assessment plan. So resort is often had to bond issues, which by the time the improvements are paid for, cost two to three dollars for each dollar of original cost. But in the meantime, other improvements are needed, and the tax rate soars, much to the disgust of the tax-payer and to the discomfort of the public official. Nor is this all. Park spaces, play grounds, community centers, school grounds, etc., are usually omitted and the growing town must acquire building lots for such purposes at excessive costs. I have dwelt on these ills at some length, as I find them to exist in most growing communities.

Procedure in Abington Township, Montgomery County, Pa.

Abington Township, Montgomery County, Pennsylvania, which lies within the suburban area of Philadelphia, has an assessed valuation of over $13,000,000, contains 16½ square miles and has a population of about 9,000 people, who live in nine separate villages. The township has a commission form of government, and is one of the 43 similar units in this State. Of late years it, too, has suffered greatly from the conditions just described.

Its Board of Commissioners has been instrumental in forming a State League of all these townships for the purpose of obtaining more favorable state legislation. To control the planning of sub-divisions, the legislature last year passed an act which provides that all plans or plots of land shall be approved by the Township Commission before they may be recorded, and also provides a penalty of $500 against the Recorder of Deeds for filing plans not so approved.

Rules for Laying Out Sub-Divisions

Immediately upon passage of this act our Highway Committee formulated the following set of rlles governing the laying out of sub-divisions, which must be substantially complied with before the commissioners will approve said plans.

Plans must give:

1. Complete block and lot dimensions, including angles, radii of curves and length of arcs. Blocks must not exceed 800 ft. in length.

2. Locations of all street monuments must be shown at street intersections, angle points and beginning and ending of curves.

3. Widths of streets, widths of sidewalk, position of curb line and building lines must be given.

4. Curb grades must all be shown.

5. Reservation of right of way not less than 20 ft. wide along natural water courses, for the township to construct and maintain sewers, is required.

6. Plans shall be filed with Township Clerk in triplicate, preferably prints on cloth.

The Board further requires that streets shall have a minimum width of 40 ft. for residence streets and from 50 to 60 ft. or more for main streets; lots shall not be less than 20 ft. front or less than 100 ft. deep. Building lines shall not be less than 10 ft. inside of street line. Sidewalks shall not be less than 8 ft. wide and all curbing at street intersections shall be circular curves with a radius of not less than 15 ft., and greater for sharp corners.

No dead end streets or offsets at street intersections will be approved, and in general sub-divisions shall be so laid out that adjoining property may be sub-divided and connected with the sub-divisions under consideration.

The approval of a plant of a sub-division does not obligate the township or the does not obligate the township or the owner to grade or pave the streets.

The Board further reserves the right to make additional requirements which it may deem necessary.

A marked improvement has already been made in street layouts and the more progressive real estate men greatly favor the new regulations.

We hope to further control the sub-division of property by the organization of a park and planning commission.

MUNICIPAL SANITARY PRECAUTIONS DURING EPIDEMIC OF INFLUENZA

Rambling Thoughts of a Civil Engineer

By Dr. Wm. Paul Gerhard, C. E., Consulting Engineer, 17 West 42d St., New York, N. Y.

PART ONE

The recurrence of the influenza epidemic in New York City during the early part of 1922, while not in as severe a form as the one which prevailed in the autumn of 1918, and which then traveled across the entire continent and affected numerous large as well as small communities, vividly reminded the writer of his personal experience in October, 1918, during an extended visit in a manufacturing and railroad town in Western Maryland.

Its population numbered about 27,000 persons, among whom about 6,000 cases of influenza occurred, many of them followed by pneumonia. The majority of cases were found in two industrial sections of the city, where the housing conditions of the workingmen, and the sanitary conditions in general, were not of the best.

No accurate returns were available because physicians became overworked. Nearly 200 deaths from pneumonia, following the influenza attack, occurred. Owing to the demands of the war, physicians as well as nurses for the sick were lacking, hence many persons volunteered from private life for nursing, ambulance and Red Cross service. Undertakers and cemetery workers became overburdened with work, funerals had to be either unduly hurried or the burials delayed. After three or four weeks of strenuous anxiety the epidemic began to subside.

The appalling calamity which befell this town was repeated in other places. In fact, the epidemic had become a pandemic* in the United States. One could not help observing the fact, which has recurred more than once in history, that "world wars and epidemics sometimes go together."

"An epidemic may well be likened to the sudden uprising and uproar of a gale, which in its mad fury uproots strong and healthy trees. Death comes, clad in a dismal and strange raiment; it shakes the nerves of the strongest and bravest of men. People feel that the causes leading to the calamity were avoidable and that the epidemic might be due to man's indifference or carelessness in sanitary matters."**

The foregoing reference applies primarily to epidemics of cholera, typhoid fever, the plague and other contagious diseases. It appears to be a mooted question whether influenza should be included in the list. At least one medical authority claims that "sanitary conditions other than overcrowding have no influence on the spread of the epidemic." The writer of this essay is not prepared to endorse this view, as his observations and reflections will show.

What Is Influenza?

An editorial Committee of the American Public Health Association answers thus: "Something is known concerning the nature of influenza, but much remains to be determined."

Physicians generally seem to know comparatively little about the disease except:

(1) That it is an acute febrile disorder, of a high degree of infectiousness, said to be due to a specific bacillus, discovered by Pfeiffer in 1892, a microorganism described as being of peculiar robustness and virulence;

(2) That the disease lowers the resistance of the respiratory organs;

(3) That pneumonia, which often follows it, is unusually fatal; and

(4) That frequently reconvalescence is slow owing to the weakening of the entire body. The disease seldom occurs in sporadic cases; as a rule it comes in the form of an epidemic, and sometimes as a pandemic, as the historical notes will show.

Influenza seems to be almost independent of the seasons of the year, of the climate, and of the weather. Usually there are more cases in winter time, reaching a maximum in January, when people are less in the open air, and a minimum in August. Influenza occurs in all zones and in all latitudes, at sea level as well as on high mountains; it attacks persons of all ages, neither children nor old people being exempted, but by far the majority of cases occur between the ages of 25 and 40. It still remains a matter of doubt whether one attack gives a person complete immunity after recovery.

While some observers claim that the microorganism has not yet been identified, it is conceded that it is carried in the matter coughed, sneezed, or spat out from nose or mouth of infected persons. Whether inert articles, such as toys, pen-

* PANDEMIC signifies spread over a whole nation.

** Quoted from a chapter in GERHARD'S "SANITATION AND SANITARY ENGINEERING."

cils, parcels, paper money, letters, clothing and shoes, when handled by patients, can contribute to the spread of the disease, is a matter about which there are differences of opinion. The disease is spread chiefly by human contact or intercourse, and travels mainly along the lines of intercommunication. Persons congregating in large numbers, and confined in closed halls, offices, workshops, or in conveyances of all kinds contribute a high percentage to the sick list.

Historical

Contrary to popular belief, influenza is not a new, nor is it a mysterious, disease. The best historical data, perhaps, are given in a treatise on INFLUENZA, published by Dr. A. Ripperger in 1892 in Munich, Bavaria. According to him, influenza became known as such first in 1387, and he enumerates the following years in which epidemics occurred in the past centuries:

1311	1403	1510	1675	1729-30	1802-03
1323	1427	1557		1732-33	1830-32
1327		1580		1775-76	1833
1387		1593		1780-81	1836-37
				1782-83	1847-48
				1788-89	1889-90
					1899-1900

According to another authority there are recorded about 100 epidemics in the 800 years prior to 1889. In Italy the disease was called "Influenza" owing to the belief that certain evil currents flowed from the stars to the earth. In France it was termed "La Grippe," in Germany the "Russian catarrh." The sudden cessation of some epidemics was popularly attributed to earthquakes and volcanic eruptions.

One of the recent severe epidemics occurred in 1889 and 1890; it traveled from Central Asia and Siberia to European Russia and to Sweden, and soon afterwards the whole of Europe became involved, and likewise the United States.

In London the percentage of persons taken ill was:

among outdoor workers...12.5%
among office workers.....25 %
among the troops..... 9.3%

The proportion of population involved in other cities is well shown by the following authentic statistics:

in St. Petersburgh and in Buda-Pest..50%
in Berlin 33%
in Nuremberg 67%
in Antwerp 33%
in Vienna.....from 30 to 40%

During the later epidemic of 1899 there occurred in England 12,417 deaths.

In the widely spread pandemic of 1918 the disease began with a sudden outbreak in Boston; it apparently entered New York City in September by a Scandinavian steamship, which brought over 11 cases. The rapid spread of the epidemic in New York City is shown by the following statistics from the N. Y. Health Department for September and October:

NEW CASES

Week Ending	Influenza	Pneumonia
Sept. 22, 1918.....	127	0
Sept. 29, 1918.....	1294	231
Oct. 6, 1918.....	9270	185
Oct. 13, 1918.....	23077	2433
Oct. 20, 1918.....	33363	4064
Oct. 27, 1918.....	26166	4490
Grand Total	93297	12369

DEATHS

Week Ending	Influenza	Pneumonia
Sept. 22, 1918.....	0	0
Sept. 29, 1918.....	42	119
Oct. 6, 1918.....	59	96
Oct. 13, 1918.....	1050	1261
Oct. 20, 1918.....	2393	2086
Oct. 27, 1918.....	2497	2015
Grand Total	6325	6032

On some days there were more than 5,000 new cases in New York, and the epidemic ran its full course despite preventive measures.

In Pennsylvania, Massachusetts and other States the epidemic was equally severe. It raged with special severity in the United States Army camps. It also spread to Canada, from Quebec to Vancouver, and traveled in one month from the Atlantic to the Pacific shores.

In the United States the pandemic cost about 450,000 lives, while in England the mortality was higher than in any year since 1850. Due consideration should be given to the fact that the records of mortality were more completely kept than in previous pandemics. The epidemic of 1918 attacked chiefly the 20 to 40 years of age group, in contrast to the belief that persons of that age would show a better resistance. It is a matter of general observation that pandemics of influenza continue for several years, and so we see it again active in 1920 and 1921.

Its recurrence in the winter of 1921-22 was largely confined to New York City. According to the U. S. Public Health Reports, New York City showed the following number of influenza cases:

Week	1st	2nd	3rd	4th	5th	6th	7th	8th
1922 ..	56	59	110	1230	5731	7070	3284	1312
1921 ..	134	78	84	72	59	84	109	102
1920 ..	100	384	5690	30456	21388	8091	3030	1069

The following comparison of deaths due to influenza and pneumonia combined from 36 cities in the U. S. is of interest:

Week	1st	2nd	3rd	4th	5th
1922	671	761	823	863	1051
1919	3165	3346	3688	3756	3180

In Europe the last influenza epidemic

appeared in December in Belgium, Norway, Sweden, Denmark, Italy, northern and southern Germany and in Turkey.

* * * * * * *

Is it not astonishing, in view of the facts cited, showing that there have been for many centuries epidemics and pandemics of influenza that the medical profession, with a few exceptions, should not be better prepared to contend successfully with the disease? In defense, attention should be called to the fact that it is extremely difficult to prevent the spread of the infection because:

(1) The period of incubation is shorter (1 to 3 days) than in other infectious diseases;
(2) The disease is infectious before the true nature of the illness is diagnosed;
(3) Because some patients, not unlike "walking" typhoid fever cases, have only mild attacks, continue to go out, and thereby contribute to the spread of the influenza.

Accordingly, precautions and preventive measures should be enforced at the very first sign of the appearance of the illness. Health boards should not wait until after it has spread.

All prophylactic measures of both *personal* and *public* hygiene are based, directly or indirectly, upon preventing infectious secretions from mouth or nose from reaching the mucuous membranes of other persons. Personal measures are of interest chiefly to physicians, nurses and patients, hence need not be consldered here. The measures, which concern the public and which we find suggested in health department bulletins and in the daily press are those recognized universally in municipal sanitation and in good hospital practice. Sunlight and fresh air are two of influenza's greatest enemies. Thus, in a Chicago fresh air school only 3 out of 700 pupils took the disease.

TYPES AND COSTS OF PAVEMENTS SUITABLE FOR TEXAS CITIES

By Julian Montgomery, City Engineer, Wichita Falls, Texas

On small paving jobs in Texas, and in the smaller cities, one course concrete pavement, or brick pavement on concrete foundation, probably would be the standard type that could be laid the cheapest, because of the small amount of equipment necessary as compared with that required for the hot mix bituminous pavements. These pavements would especially be cheaper if good local material were available. It is true that the concrete pavement requires some four weeks for curing. It is also true that patching concrete pavements properly is a slow, painstaking job, which at times requires that the streets be barricaded for several days. However, in the smaller places the traffic is not so congested and neither is the matter of some four weeks of time so important.

Study of 65 of the Smaller Town Pavements

In these smaller places probably the vitrified brick would be used most in the business section rather than in the residential district. A study of the types of pavement in 65 of the smaller towns and cities of Texas shows that vitrified brick and Portland cement concrete predominate in three-fourths of them. It is also likely that when some of our larger cities were smaller, types other than the bituminous ones were laid first.

When the towns develop into cities, and the cities grow larger and larger, the congestion of traffic by commercial and pleasure vehicles demands a rigid economy of time necessary for the construction of the pavements, and also for their maintenance.

Fifth avenue, New York, the most heavily traveled street in the world, is paved with sheet asphalt. The traffic is fairly light and quick moving. This type of pavement is excellent for Fifth avenue. It can be quickly repaired and stands up well under the types of traffic seen on Fifth avenue. For a dense traffic composed of heavy trucks, wood blocks or vertical fiber brick probably would be better types.

The larger cities always have enough pavement construction in view to warrant the construction companies engaged in laying bituminous pavements to install the comparatively expensive machinery necessary to lay this type. Bitulithic, Rock Asphalt, Willite and asphaltic concrete are some bituminous types with which practically every city official in Texas is familiar.

The residence districts in the cities demanding pavements usually give attention to the aesthetic considerations, or the pleasing effects of the pavement. The citizens usually prefer to pay more, if necessary, to obtain a type of pavement that will add the most beauty to their streets. The city officials also consider the pleasing effects, and rightly take the experience of the contractor into consideration. They realize from their own

experience that an inexperienced contractor cannot put the finished effect to the work no matter how hard everyone tries to help the work along.

Preferred Types in the Larger Cities

A questionnaire sent to the City Engineers of the larger cities in Texas shows that the preferred types of pavement for the business districts are the vertical fibre brick and asphaltic surfacing on concrete base. Of the asphaltic types preference is given to the Bitulithic pavement. During the past year it has been practically impossible to obtain paving brick. In the city of Wichita Falls we have not considered brick on that account, and the very high prices of brick pavement. Reinforced concrete pavement is now the cheapest pavement we are laying in the business district. This, however, has its drawbacks, as it causes the merchants considerable loss in keeping the street closed some four weeks for curing.

The questionnaire also shows that for the residence districts the preference is practically unanimous for an asphaltic type of surfacing on either concrete or rock base, depending upon local conditions.

A study of the pavement development in the cities and towns of Texas shows, therefore, that concrete and vitrified brick pavements are more popular in the smaller places. It is usually more economical to build these types, and the time factor is not so important, nor is the aesthetic taste so highly developed. In the larger places we find the asphaltic types more popular. These types, when constructed by experienced contractors, give the most pleasing appearance, and are thrown open to traffic immediately after being laid. They also permit of easy repair, all of which means a distinct saving of time. Possibly one type of asphaltic pavement is as good as another if properly constructed. The probable reason that some well known types are so popular is that the companies laying them have had years of experience and maintain them rigidly.

Amount of Paving of Various Types

On June 1, 1920, there were 14,234,125 sq. yds. of pavement in use in Texas cities and towns.

30.5% of this was Bitulithic.
18.5% was brick.
12.4% was Asphaltic concrete.
8.2% was Portland cement concrete.
7.0% was Uvalde Rock Asphalt.

Costs of Pavements

Many people of today are wont to compare costs before 1916 with those of the past year and the present costs.

The circumstances governing costs before 1916 and those controlling the costs of the past year were so different that no direct relation could be said to exist. Outside of the bare comparison of prices for the same unit, further analyses and cross-comparisons are nearly impossible, because the circumstances governing the different units were so markedly different themselves.

These conditions with regard to transportation, labor, materials, equipment and living conditions are gradually approaching normal again. The approach to normal is not so perceptible, however, for some things and in some localities. Yet the general trend is in that direction.

High Freight Rates Greatly Delay Paving in Texas

The one great exception to such an assertion is that of freight rates. The high freight rates have greatly delayed pavement construction in Texas. The delayed paving work is directly traceable to them. During the past year freight rates on paving materials shipped to Wichita Falls have increased per ton as follows:

Rock	$0.90 to $1.20
Sand	1.10 to 1.50
Asphalt	5.15 to 7.00
Cement	3.60 to 4.90

Similar increases were felt in practically every city in Texas. The high freight rates have placed pavement construction in Texas, on the whole, at least one year behind the paving programs originally outlined.

On the other hand freight cars have become very plentiful. Shipping service is good. Delays to any great extent in transportation are no longer experienced. It is likely, of course, that the increase in freight rates has accounted for this plentiful supply of freight cars.

Labor has "about faced" from the independent attitude assumed a year ago, and now labor is more than plentiful. Wages have decreased, and the laborers themselves possess a higher morale, and work much harder for the lower wages.

Wages in Texas

About the first of June, when these data were prepared, wages for labor in various cities of Texas were as follows:

El Paso	$1.50 to $2.00
San Antonio	2.00 to 2.50
Beaumont	2.80
Galveston	4.00
Houston	2.80 to 4.00

Dallas 3.20
Ft. Worth 3.20
Wichita Falls ..... 3.20 to 4.00

Strong Demand for Paving Materials

The price of paving materials at the shipping points has decreased somewhat during the last six months. This decrease, however, was just about neutralized by the increase in freight rates. The demand for paving materials has been strong. While the relative amount of pavement construction in any one place may have been small, the vast road building programs inaugurated by the counties of Texas, in cooperation with the State Highway Department and the Federal Bureau of Public Roads, have made the total demand unusually great.

Texas Counties are Active

The counties of Texas alone have many millions of dollars at their disposal for good roads. Contracts to the extent of some twenty-three millions of dollars have already been let by the counties. In addition to this the cities of Texas propose to spend some six or seven millions of dollars this year for street pavements. Construction material will be in demand for several years, it seems, and the prices will depend upon labor, fuel, and the demand for the material.

Deliveries upon construction equipment are much better now than they were a year or so ago. Today rollers, excavators, graders and the like can be obtained from within two weeks to one month. Concrete mixers, especially certain types, are harder to obtain. Much of the equipment on the market today was manufactured by high priced labor and using high priced material. Prices of equipment will not decrease materially until the more costly manufactured equipment has been sold and that made by cheaper labor and containing cheaper material can be placed on the market. This will follow more quickly for some types than for others.

Living conditions have more closely approached normal in some places than they have in others. These living conditions are reflected in the prices paid for labor. Those places where living standards are more expensive must expect to pay more for labor, and, in turn, more for their pavements.

Factors Affecting Pavement Costs

Summing up the factors affecting pavement costs it is seen that:

1. Freight rates are still high.
2. Labor cost is decreasing as rapidly as living conditions will permit.
3. The demand for materials will have a tendency to keep the price of materials up and cheaper fuel and cheaper labor will reduce the cost of materials. Cities possessing local materials will, of course, be able to construct pavements cheaper than those that have no local materials.
4. Equipment becomes cheaper in just so far as that made by cheaper labor and containing cheaper materials is mar-

TABLE I—VARIATION OF PRICES OF PAVEMENTS IN TEXAS CITIES.

City	Type Pavement	Price Per Sq. Yd.	Curb or Curb and Gutter	Labor	Date of Letting
Fort Worth	2″ Bitulithic on 5″ concrete base	$3.55	$0.65 (curb)	$3.20	8- 8-21
Dallas	3″ Bitulithic on 5″ concrete base	3.95	1.40		6- 3-21
Paris	2″ Bitulithic on 5″ concrete base	4.12	1.60	2.80	4- 1-21
Paris	2″ Bitulithic on 7″ gravel & stone base (local)	2.95	1.70	2.40	4- 1-21
Waxahachie	2″ Bitulithic on 5″ concrete base	3.55	1.25		4-19-21
San Antonio	Concrete	3.15		2.00 to 2.50	5-26-21
San Antonio	Bitulithic on Macadam base	3.35		2.00 to 2.50	5-26-21
San Antonio	Uvalde Rock Asphalt Macadam base	2.80		2.00 to 2.50	5-28-21
Houston	2″ Bitulithic on 6″ concrete base	4.25		2.80 to 4.00	1- 8-21
El Paso	1½″ Bitulithic on 6″ stone base	2.28		1.50	5-19-21
Beaumont	2″ Asphalt on concrete base	8.73 per ft. for 22-ft. pavements		2.50	4-19-21
Wichita Falls	8″ reinforced concrete	3.73	0.65 (curb)	4.00	6- 6-21
Wichita Falls	2″ Bitulithic on 5″ concrete	4.23	1.50	4.00	6- 6-21
Wichita Falls	2″ Uvalde on broken stone base	3.87	1.35	4.00	6- 6-21
Wichita Falls	2″ Uvalde on concrete base	4.31	1.35	4.00	6- 6-21

keted. Since most experienced contractors possess a considerable amount of their equipment already, this will not affect present prices materially.

5. Living conditions and living standards affect the price of labor. The cost of pavements is cheaper where Mexican labor is plentiful since their living standards are lower.

6. Eliminating the differentials of local material, cheap labor and cheap living conditions, and living standards, then the prices of pavement in the different sections of Texas will vary but little.

Table I will give an idea of the variation in prices in the larger cities of Texas that have had recent pavement lettings.

Additional Cost Due to State Paving Law

There is still one thing that has not been mentioned with regard to pavement costs. That is the aditional cost entailed by the State Paving Law.

The present paving laws delay the paving of the streets materially. So many resolutions, ordinances, reports, and hearings are necessary, and the amount of time required for each step or procedure is so long that the total time required from the advertising for bids to the actual beginning of the construction is from two to three months. Even then something may creep in, or something be left out, so that uncertainties may develop.

It actually costs contractors more money to handle all of the required legal proceedings entailed by the State Paving Law. The extra time necessary means in many cases that their organization is tied up much longer than the time required to do the actual construction. The cost of possible lawsuits must be taken into consideration. Paving certificates must be carried from two to four years—and *all* of the property owners pay the cost.

At the last pavement letting in Wichita Falls the contractors were asked to state in their proposal the discount they would allow on complete cash payments. The discounts allowed by them ranged from zero to 10 per cent. This is an experiment on the part of the City of Wichita Falls. It remains for the future to tell whether or not it will be worth while. The people that can afford to pay cash are the ones that get the benefit of the discount. If the total contract cost of the pavement could be paid upon monthly and final estimates, the prices could be appreciably reduced.

Why Counties Get Better Prices Than Cities

As a general rule our counties pay the whole cost of road work in cash. A comparison of the contract prices that can be obtained by counties with the prices bid on city paving shows that the counties can get similar work done for considerably lower costs. The great difference against the cities is the overhead expense of the paving contractors doing city work. They must accept paper in payment for the bulk of their work. They must discount this paper through brokers, and at the present time the discount they must allow is relatively large. All of this the property owner must pay.

The Homestead Law

While we are revising things, let's not overlook the Homestead Law. This law makes it impossible to pave in front of a homestead unless the owner agrees to sign the necessary lien. Often property owners who can well afford to pave, refuse to do so, and leave an unsightly gap in the pavement which often causes the traveling public a great inconvenience.

The time has come when community rights must be considered. One person should not be allowed to make a whole community suffer. There should be some kind of a law that would force property owners to pave under certain conditions. This means a revision of the constitution. Texas is practicaly the only state in the Union, where, in the name of "Individual Rights" such stumbling blocks are placed in the path of Community Development. The need for such precautions are past. As long as the benefits to the property exceed the cost, then the improvement should be made, forcibly or otherwise.

The foregoing matter is from a paper presented by Mr. Montgomery before the latest annual meeting of the League of Texas Municipalities.

MAKING IRRIGATION BONDS SALEABLE

By John L. Hershey, of Hershey & Mirick; Consulting Engineers, Lincoln, Neb.

For some years past, irrigation securities have been in disrepute with the investing public, and possibly there has been good reason for much of the feeling against them. However, if there is to be irrigation development, other than the regular government reclamation projects, something must be done to give legitimate bond issues for irrigation development the standing they should have among investment securities.

There are still many good projects which should be developed in order to increase the producing and taxable value of many thousand acres of western land. In order to do this, bond issues against the land will have to be floated, and until there is some means for the investing public to distinguish the sheep from the goats, and for relieving the general suspicion against all issues, however valuable they may be, little can be accomplished.

Just at this time the market value of land in general is too low on account of the reflex action due to over-valuation during the war period and the two years immediately succeeding it. Conditions must soon begin to improve, however, and as soon as the foreign markets open up and a certain amount of desirable readjustment takes place, interest in farm lands and their full development will revive.

Drainage in many parts of the United States, and irrigation in the arid and semi-arid West are two great contributing factors in increasing production, and by so doing, increasing both marketable and taxable values. Drainage, probably on account of its more general distribution and the better laws governing its development, seems to be in better shape than irrigation. Drainage district bond issues certainly have a more ready sale than district irrigation issues, though it must be admitted that 87½ per cent or 90 per cent is altogether too great a discount for either. The writer understands that the above discounts are about the average for those issues which can be disposed of.

Schemes That Failed

There was a period between 1906 and 1913 when a large number of privately-financed irrigation schemes were put through, and it is a well-known fact that many were poorly conceived, poorly financed, and we must admit it, the engineers were often too optimistic. Districts were formed during this period with insufficient water for the land under development, and the total cost of promotion, financing and construction put a tax of from $50 to $100 or more per acre on raw, undeveloped land, the expectation being that its value would immediately increase to $300 or $500 per acre. The cold facts are that some of these propositions were almost worthless and the payments on bond issues defaulted. Even on some, in which the ultimate value was considerably more than the bonded indebtedness, interest payments lapsed and the bonds were so scattered that judgment against the property in the courts was impossible to obtain from lack of concerted action.

To guard against the above condition, some of the far-western states have put the official stamp of approval on district bond issues, making them a legal investment for trust funds, banks, and insurance companies.

The California Law

The California law, on which at least two other states have based similar statutes, places the legalizing of any irrigation bond issue in the hands of a commission made up of the attorney general, state engineer and the superintendent of banks. A bond issue first requires a vote of four-fifths of the qualified electors of the district, after which the commission reports on the water supply, nature of soil, feasibility of irrigation system or contemplated work, reasonable market value of water rights, reasonable value of lands, and on whether the amount is less than 60 per cent of the market value of water rights and lands. After the commission has acted favorably upon an issue, the bonds become a legal investment as above stated, being listed fourth in the desirable issues for the investment of mortgage insurance company's capital.

Oregon and Idaho Laws

Oregon has a very similar law, its commission is made up in the same way and the bonds are a legal investment for all trust funds, funds of insurance companies, banks and trust companies.

In Idaho, the district irrigation bonds, after being passed upon, also become a legal investment for insurance companies, trust companies and savings banks. In this state these bonds are third in the list of desirable investments, being classed with city, town, county and school district bonds.

The Nebraska Law

In Nebraska, the law governing the formation and working of an Irrigation District seems comprehensive and complete except that it does not require sufficient financial investigation and the approval of some authoritative state board other than that of the Department of Public Works, which passes only on the physical features of the project. Under the existing laws bonds may be issued against the district for buying water rights, canals and reservoirs, or for the construction of new works, and if the bonds can be given a perfect legal history, if the water supply is sufficient and

the construction plans adequate, no further restriction is placed upon them.

District bonds in Nebraska run for 20 years, draw interest only for the first 10 years and pay gradually increasing sums during the 10 to 20-year period. Interest and principal are payable as taxes, and as the bonds are a first lien on the land, it may be sold for the non-payment of interest or principal. It would seem, therefore, that there should be no trouble in making collections, especially if the land is well developed and producing good crops, so that the main thing for the investor to consider is the value of the property and the total amount of bonded indebtedness.

Illustration of Difficulty of Selling Bonds

Just how difficult it is to dispose of irrigation bonds is well illustrated by the experience of one of the oldest and best-established districts in the state of Nebraska. This district comprises 10,000 acres of well-improved and highly-developed land with a good water right and distributing system. The water rights and canal system cost the district $150,000, for which it issued bonds which are now in their tenth year. Interest payments have always been met promptly and the district is in a good financial condition. In order to increase its water supply so that there will be no failure of water at any time, and to extend its boundaries 3,000 or 4,000 acres, the district has voted a $125,000 issue, which would bring the total bonded indebtedness up to $275,000, or $27.50 per acre. Now, though the land has increased in value from $70 per acre at the time of the first bond issue to from $125 to $175 per acre, and would be worth from $25 to $50 more after the new development, it has been impossible for the district to interest the bond buyers enough even to talk seriously of floating the issue.

The above illustration is given merely to show the feeling against irrigation bonds in general in the central West, as this particular proposition is so obviously a good risk that it should be snapped up on its merits.

It seems to the writer that such a condition is worth the serious consideration of all those interested in irrigation development. It may be that more or less uniform laws following those of California, Oregon and Idaho, giving worth-while bond issues of irrigation districts a legal status by action of a well-balanced committee of state officials, would have the desired effect and give them a good financial standing.

REFUSE DISPOSAL BY INCINERATION IN INSTITUTIONAL AND INDUSTRIAL BUILDINGS

By William F. Morse, Consulting Sanitary Engineer, 1007½ Kee Mar Park, Cleveland, Ohio.

A recent technical work on the subject of refuse is devoted almost exclusively to the collection and disposal of municipal refuse, and but little reference is made by the authors to the methods and apparatus used by the great public institutions, railroad terminals, markets, hospitals, private industrial establishments, medical schools and colleges, U. S. Government posts, and many other places where incineration is employed as a means of waste disposal. Yet, taken altogether, the number of these smaller installations is far greater than that of the municipal disposal plants, and in the aggregate the daily quantities dealt with will nearly equal the amounts handled by the civic plants.

The usefulness of these minor installations is established beyond question. In some cases they are used by municipalities in their larger institutions, but a far greater number are installed by private enterprise for the disposal of worthless matter produced on the premises, which is troublesome to deal with in any other way than complete destruction.

Disposal of Market House Wastes

For the disposal of the waste of market-houses there is no method so satisfactory as incineration on the premises. Given a market containing from 100 to 150 stalls, handling every variety of food products, there is a daily accumulation of refuse material of from 10 to 15 cu. yds., weighing approximately 3 to 5 tons, according to seasonal conditions. If this is hauled to a dump by truck or wagon the daily cost is a considerable item in the administration expense. A small percentage of the waste—the meat cuttings, fat and bones—have value, but the greater volume of miscellaneous rubbish, which consists of animal, fish and vegetable refuse, paper, wood and metal, paper containers, floor sweepings and contaminated matter of every description, must daily be removed or destroyed, and this disposal must be in accordance with the sanitary laws, and without nuisance or offence to persons or property.

The Incinerator

The apparatus for incineration is not complex in design; it can be built from detailed working drawings by a compe-

tent bricklayer who can read plans and follow clearly printed instructions. The design may be varied to conform to the architect's plans, or to suit a limited floor space, or chimney or boiler flue connection, but the floor space for the Incinerator must not be less than 8 ft. by 6 ft., with room on side or end for stoking and removal of ashes.

Upon receipt of preliminary information each Incinerator is specially designed for the required location. Usually this is the basement or cellar floor, and the Incinerator is connected with the main chimney of the heating plant, or with the boiler smoke flue; or, if the location be outside the building, there is provided a brick chimney or steel stack with firebrick lining, rising above the top of the market building, or higher if this is necessitated by the height of the surrounding buildings.

The fire-box, floored with heavy cast-iron grates, is charged from the main floor of the building through a chute covered by a fire-clay slab enclosed in a cast-iron rotating frame. The interior walls, roof and connecting flue are of the best quality of firebrick, and the whole construction is braced and stayed by vertical and horizontal steel beams and angles. No iron is exposed to the flame except the face of the castiron lining of the stoking door. The consuming heat may be raised to the highest temperature and maintained indefinitely without injury to the furnace. The design may be varied to charge from the side or from the end, to suit local conditions.

Construction and Operation of One Market House Incinerator

The continuous observation for three years of an Incinerator placed outside a market house containing 150 stalls, with a separate steel stack of 75 ft., may be taken as an example in construction and operation. Early in the morning the fireman in charge gives his assistance in collecting the refuse, and this is brought to the incinerator, which has previously been thoroughly cleaned of ashes, clinkers, iron, wire, glass and all other incombustible matter, usually about one barrow load. The largest tins are thrown out, as these interfere with the firing. The furnace is then charged with 3 cu. yds. of mixed refuse. Frequently a barrel filled with vegetable matter is dropped through the charging-port to the fire-bars below. No other fuel is required or has ever been used during the whole period of operation of this furnace. Combustion proceeds in the natural way, that is, by burning from the bottom, not from the top. This is done in the furnace itself; the smoke, gases and fumes pass through flues into the combustion chamber, where is completed the final transformation into CO_2. During the charging period of one minute the down draft through the chute prevents the emission of smoke or fumes of combustion.

The practical results of this installation are the destruction of all mixed market waste without the use of fuel other than the material burned, the intermittent labor of one man only, and the disposal of worthless matter in a sanitary way, without nuisance, at an extremely low cost.

The initial expense of the installation is very moderate when compared with the benefits that follow the adoption of this method.

In larger public or private plants or buildings, where the amount of waste is large, and it is costly to remove it, installation of an incinerator solves the problem in a thoroughly satisfactory way.

Incinerators at Railway Terminals

In the great Hudson Terminal Building, New York City, which has 5,000 daily occupants and a connecting underground railway, there is installed an incinerator designed and built by the writer in 1907. This furnace has been in continuous operation for 15 years. The conditions in this building required a furnace with the capacity of 10 tons to receive the daily garbage, combustible refuse, floor sweepings from the rooms and corridors cleaned by the vacuum process, and the refuse from the railway used by thousands of travelers. All the conditions were successfully met, and the superintendent of the building in recent conversation with the writer remarked, "I could not do without the incinerator."

In a similar way, the enormous volume of refuse from the multitude of industrial plants housed in the Bush Terminal Building at South Brooklyn, N. Y., is transformed into steam by the aid of two large incinerators which use no other fuel, and operate two 350 h. p. steam boilers, saving an equivalent amount of coal.

Other terminal and way stations on the Pennsylvania, Reading and Baltimore & Ohio Railways, in New York, Philadelphia, Baltimore, Washington, and other cities of the south and west, use this form of disposal for every kind of refuse.

The U. S. Government was among the first to recognize the value of this means

Hinsdale-Downers Grove Road, Downers Grove, Ill. "Tarvia-X," 1920

What did the Winter do to Your Roads?

In communities where the annual Spring thaw turns roads into mires of soggy mud, Spring is a season of discomfort and isolation.

Throughout the country, there are still thousands of such communities. Perhaps yours is one of them. Perhaps the picture at the top of the page is typical of some roads in your locality.

Now look at the Tarvia Road shown at the right. This road is waterproof and frost-proof. Neither the freezes of Winter nor the thaws of Spring have any effect upon it. This highway is firm, smooth, dustless and mudless all the year round.

Your community—*any community*—can afford such roads. They are comparatively low in first cost, and are so much more economical over a term of years that the saving makes a more extensive road program possible. In many cases the old macadam or gravel can be utilized as the foundation for a traffic-proof Tarvia top.

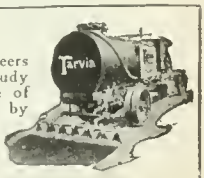
We would like to tell you more about the many uses of Tarvia, its ease of application and its economy as a maintenance material for hard-surfaced roads and pavements of every type. A letter addressed to our nearest office will bring you facts, figures and pictures.

No highway engineer or road official should be without a copy of our latest manual, "Road Maintenance with Tarvia." Our nearest office will gladly send free copy upon request.

Tarvia
For Road Construction Repair and Maintenance

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.



New York, Detroit, Peoria, Youngstown, Baltimore, Chicago, New Orleans, Atlanta, Toledo, Omaha, Philadelphia, Birmingham, Duluth, Columbus, Jacksonville, Boston, Kansas City, Milwaukee, Richmond, Houston, The Barrett Company, St. Louis, Minneapolis, Bangor, Latrobe, Denver, Cleveland, Dallas, Washington, Bethlehem, Cincinnati, Syracuse, Johnstown, Elizabeth, Pittsburgh, Salt Lake City, Lebanon, Buffalo

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

of waste treatment. The first permanent installation for an army post was designed by the writer in 1894, and is *still in use*. Space will not permit more than a passing reference to installations in four Navy Yards and very many others in Army Posts built by the writer, all of which are in active service.

There is hardly any form of refuge that fire will not affect; and there is no combustible matter that cannot be destroyed in a properly designed and efficiently operated incinerating furnace. Moreover, the work can be done in strict compliance with the regulations of the municipal authorities, and with practical, economical results that no other method can equal.

SOLVING A TYPICAL ROAD PROBLEM IN THE SWAMP LANDS OF ARKANSAS

By B. H. Klyce, Civil Engineer, 720 Fourth and First National Bank Bldg., Nashville, Tenn.

Given two thriving towns twelve miles apart connected by a dirt road across a very poorly drained country, much of it swampy, but very productive when properly and completely drained: Problem—To build a road which will be serviceable the year round. Such was the problem in Craighead County, Arkansas, for the two towns of Nettleton and Lake City.

The country in this locality slopes gently in a generally southerly direction with a slope of about 1 ft. to the mile, while the proposed road was to run east and west. There were four drainage ditches crossing the road at right angles.

There were numerous but relatively short stretches of gumbo with its characteristic quality of absorbing water very readily and then retaining it tenaciously; a very small amount of water is sufficient to render a section of gumbo road impassable for long periods of time.

There were no road surfacing materials locally available. Funds were limited as usual.

Under these conditions it was deemed necessary to raise the road above the general level of the land, to build a dike in fact. Drainage ditches with from 3 to 12 ft. of bottom width and varying in depth from 3 to 8 ft. were excavated alongside the roadway.

Since there was no outlet for these roadside ditches except for the above mentioned intersecting main drainage ditches and which were located from one to five miles apart, it was necessary to carry the water alongside the road for long distances. This road is consequently distinguished by the almost total absence of culverts. There is little erosion, however, because of the low velocity of the water.

For practically all of the excavation, dry land dredges of the walking type were used; these dredges straddled the ditches and deposited excavated material in the roadway, where it was later leveled with a road grader pulled by "caterpillar" tractor.

The road right of way was from 60 to 80 ft. in width. The roadway fill was planned with a minimum top width of 28 ft. ,allowing 18 ft. of pavement with 5-ft. shoulders.

Most of the excavation was completed a year in advance of construction of the paving, thereby allowing the rains and traffic to settle the fills as much as possible.

All sections of the road composed of gumbo were covered with several inches of sand or sandy loam, such as was locally available; traffic was allowed to incorporate the sand in the gumbo. This treatment was found quite effective in taming this bete-noir of the road engineer, greatly improving such sections and rendering passable roads which had formerly become impassable with every shower.

Water-bound macadam to a width of 18 ft. and with a bituminous surface treatment was adopted as the paving material. It is intended after a few years when thorough settlement has taken place to use the macadam as a foundation and place on it a higher class wearing surface.

The above features of road construction in low lying or swamp land are not new, but it was thought they might be of some interest to our brother engineers in the highlands.

Payne Dean Limited, 103 Park Avenue, New York City, manufacturer of Dean Control for electrical operation of water, gas and high pressure steam valves, has established offices in Pittsburgh and Chicago. Mr. C. J. Burrage, late Captain of the A. E. F., and formerly of the Engineering Department of the Cutler-Hammer Mfg. Co., is in charge of the Pittsburgh office in the Bessemer Bldg. Mr. A. H. Kohlbusch, late Superintendent of Construction for the Public Service Electric Co., has been placed in charge of the Chicago office in the Lumber Exchange Bldg., 11 S. LaSalle Street.

WATER WORKS SECTION

METHODS AND COSTS OF BUILDING 10 MILLOIN GALLON, REINFORCED CONCRETE RESERVOIR FOR THE INDIANAPOLIS WATER CO.

By William Curtis Mabee, Assistant Chief Engineer, Indianapolis Water Co., Indianapolis, Ind.

The Indianapolis Water Company built and placed in service in 1921-1922 a 10,000,000-gal. reinforced concrete, covered reservoir, complete with pipe connections and appurtenances, but excluding engineering, at a total cost of $223,500.

The site chosen for the new reservoir was formerly part of the open infiltration gallery at the Riverside Pumping Station, constructed in 1882 and abandoned as a source of supply in 1907 when the first covered reservoir at this station was built.

Depth

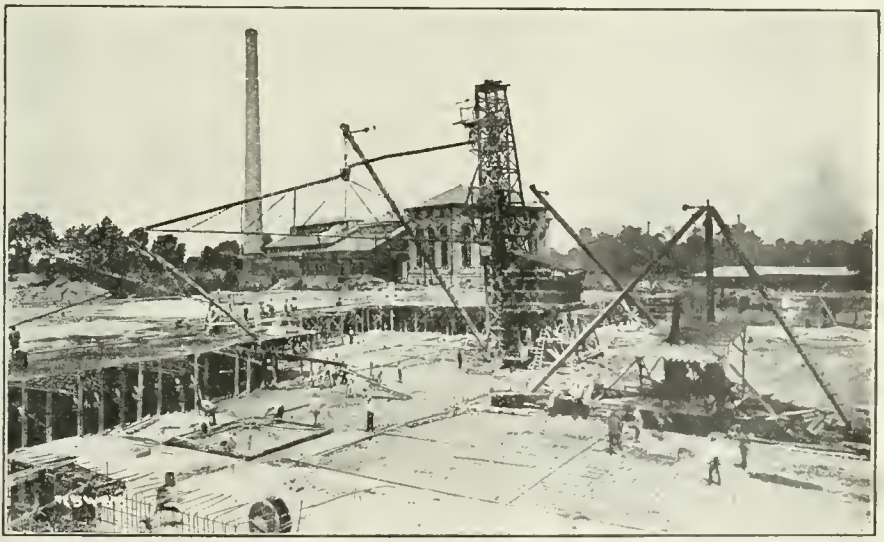
In determining the depth of water to be stored in the new reservoir it was necessary to consider the hydraulic gradient of the supply conduit which discharges filtered water at this station, as affecting the upper limit of elevation of water stored and a further consideration of the ground water level at this station as the lower limit, keeping in mind the danger of rupture from rising ground water levels. The depth of water stored, 10 ft., and 3 ins., was therefore fixed by these limitations.

It was considered advisable and necessary so to design the reservoir that a rise in the ground water level of 10 ft. would be counterbalanced by the weight of the structure and the superimposed loading of earth upon the roof of the structure without consideration of the weight of the water contained within the reservoir.

Groined Arch Floor

This excessive upward pressure of ground water during flood stages, calculated to be exerted at a time when the reservoir might be empty, and the necessity of an equal distribution of downward pressures upon the soil presented a problem in the design of the floor which obviously could best be solved by the employment of the groined-arch type of floor construction.

It may also be noted that the groined-arch floor forming intersecting valleys



VIEW SHOWING VARIOUS STAGES IN THE CONSTRUCTION OF THE 10 MILLION GALLON, REINFORCED CONCRETE RESERVOIR OF THE INDIANAPOLIS WATER CO.

can be the more readily flushed when necessary to clean.

Flat Slab Roof

While a groined arch roof would have been as satisfactory as the flat slab type of construction adopted, experience here as elsewhere has shown that contractors as a rule prefer to build along lines with which they are familiar and will for that reason submit lower prices for the flat slab type of construction than for the groined-arch type, notwithstanding the groined-arch roof requires practically no steel.

Earth Covering

The necessity of weighting the structure suggested the use of 27 ins. of filling on the cover ,assumed to weigh when saturated 250 lbs. to the square foot. This fill also prevents the formation of ice in the reservoir and tends to maintain the roof slab at a reasonably uniform temperature in all seasons ,thereby minimizing the distortion of the structure from temperature changes.

Loading

The total live and dead load considered upon the roof slab was 470 lbs. per square foot or a superimposed load of 350 lbs. per square foot.

Having determined the type of structure to be constructed and the loading to be supported, the question of column spacing was next considered.

Column Spacing

The usual spacing for work of this character varies from 15 to 25 ft. and for the loading under consideration the slab thickness would vary from 7½ ins. for the 15-ft. spacing to 12 ins. for the 25-ft. spacing; the column spacing could even be made as little as 10 or 12 ft. centers. There is no doubt in the writers' mind that the structure with the smaller column spacing can be built for less money; but considering the ground water problem and the desirability of heavy sections lending their weight, strength and dependability to the structure in addition to the degree of impermeability required in a structure of this character, the column spacing that would satisfy these requirements was determined to be 18-ft. centers.

The first slab is designed in accordance with computations based upon the rulings of the American Concrete Institute for four-way reinforcement. Columns are 24 ins. diameter, spaced 18 ft. center, each reinforced with eight ⅝-in. round bars and ¼-in. tie bars.

The reservoir is rectangular with rounded corners, inside dimensions 254 ft. wide, 542 ft. long and 10 ft. 8½ ins. deep, with a storage capacity of approximately 1,000,000 gals. per foot depth.

Data on Costs and Prices

The net area for water-surface-is 136,500 sq. ft., or 3⅛ acres, and the cost per million gallons stored exclusive of piping connections, brick baffle walls and engineering, but including all earth work was $19,150, equivalent to $1.41½ per sq. ft. of water surface.

Expressed in percentage this cost was divided as follows:

Excavation, average cut 11-ft.....15.6%
Refill, 27-ins. deep on cover..... 7.1%
Levee Embankments 2.0%
Concrete Structure including sub-grading 75.3%

The typical labor charges upon which these costs were based were:

Common Labor .....30 cts. per hour
Skilled Labor .....35 to 60 cts. per hour
Form Builders .....60 cts. per hour
Teams .....75 cts. per hour

All levee work was done by force account for which the company allowed the contractor cost plus 15%.

Quantities Involved

Earthwork—80,319 cu. yds. of which 52,175 cu. yds. were excavation from reservoir site placed into embankments and spoil banks and 28,135 cu. yds. refill over and around structure and in shaping levees.
Concrete—11,158 cu. yds.
Cement—15,523 barrels.
Steel Bars—464 tons.

Plans and specifications for the work were prepared and the work divided into two parts; (1) Excavation, and (2) Concrete work including Refill.

Excavation

Bids were received for the excavation work Feb. 15, 1921, from six local contractors as follows:

	Per cu. Yd.
American Construction Co.....	$1.10
Timberlake Construction Co.....	0.88
Sheehan Construction Co.....	0.90
Mansfield Engineering Co.....	0.738
Harold & Butner.....	0.90
R. H. Scott & Co.....	0.56

The contract was awarded the lowest bidder, R. H. Scott & Co., Feb. 26, 1921; the unit price of 56 cts. per cu. yd. included all clearing and grubbing of trees and the segregation of the loam, sand and gravel into separate piles, the earth and rejected gravel going into embankments and levees.

This work was completed and final payment made Aug. 6, 1921; elapsed time 5 months 11 days. Quantity of material handled: 52,175 cu. yds., including 10,000 cu. yds. of sand and gravel which was washed and screened from the excavation

for concrete work under a supplementary contract.

The dimensions of the excavation were 280x570 ft.; area 3 2-3 acres, with a cut varying from zero to 23½ ft., the average being 11 ft. The character of excavation was top soil and bank gravel, the work contemplated filling an abandoned infiltration gallery or reservoir which extended diagonally across the site for the proposed new structure with sand and gravel from the excavation and rolling the fill with a locomotive crane, the expense of rolling being paid for on force account.

Gravel which was suitable for concrete was washed and screened and stored in piles upon the old infiltration gallery site at an additional cost of 40 cts. per cu. yd. The top soil was carefully selected and stored in piles conveniently located for top dressing the embankment after the completion of the structure.

Excavation progressed at the following rates: First month 21%, second month 42%, third month 15%, fourth month 14%, fifth month 8%.

The equipment consisted of a locomotive crane operating a yard and a half clam bucket which was used to fill the old gallery and which was also used to elevate gravel to the washing platform. The larger part of the excavation was handled by teams and wheeled scrapers.

The average rate of excavation for elapsed time was 324 cu. yds. per day and the maximum rate for 30 days was 750 cu. yds. per day.

Earth Refill and Embankment was included in the contract for concrete work and was handled by wheeled scrapers as follows:

17,985 cu. yds. at 55 cts. per cu. yd.
10,150 cu. yds. by force account cost 75 cts. per cu. yd.

Total excavation and refill, 80,310 cu. yds. at an average cost to the Water Company of 58 cts. per cu. yd.

The average rate of embankments for elapsed time was 230 cu. yds. per day and the maximum rate for any month was 293 cu. yds. per day.

Concrete Work

Eleven bids were received for placing 11,158 cu. yds. of concrete, the Water Company furnishing all cement and steel to the contractor on board cars at Water Company's switch and also delivering gravel to the site, the contractor unloading, hauling and storing cement and steel, furnishing all material for forms, centers and supports; bending, setting and securing all reinforcing bars, mixing and placing concrete and fine grading and tamping the bottom of the reservoir. The bids follow:

	Per cu. yd.
Henry Mang	$15.08
W. P. Jungclaus Co.	13.50
Hoffman Construction Co.	11.50
Warner Construction Co.	11.00
J. G. Karstedt	10.00
Hall Construction Co.	8.72
Dodge & Heiby	7.82
J. W. Martin	7.77
R. H. Scott	6.90
Bunting Construction Co.	6.75
Mead Construction Co.	6.35

The contract was awarded the Mead Construction Co., the lowest bidder, May 26, 1921, and was finished Oct. 24, 1921, the day before the time set in the contract for completion. The placing of concrete began June 27th and was completed in 120 days elapsed time. Average daily progress for elapsed time (120 days), 93 cu. yds. Maximum day, 328 cu. yds. Average monthly progress, 2,800 cu. yds. Maximum month, 5,323 cu. yds. Expressed in percentage the rate of progress follows: June 2%, July 25%, August 48%, September 21%, October 4%; total 11,158 cu. yds.

The Water Company furnished 15,523 barrels of cement at a cost of $2.44 per barrel, which the contractor handled for 19 cts. per barrel; 464 tons of steel bars cost the Water Company $2.58 per 100 lbs., including the cost of bar spacers and was placed for $15 a ton; 5,505 cu. yds. of gravel were purchased at a cost of $1.53 per cu. yd. and 8,443 cu. yds. of gravel were reclaimed from the excavation at a cost of 47½ cts. per cu. yd.

Concrete Costs and Quantities

The concrete was mixed 1:2:4 and required 1.39 barrels of cement, 83 lbs. of steel and 1.25 cu. yds. of gravel. The unit cost of concrete to the Water Company, excluding engineering, follows:

Cement	$3.40 per cu. yd.
Steel Bars	2.15 per cu. yd.
Gravel	1 11 per cu. yd.
*Labor (by contract)	6.39 per cu. yd.
Total	$13.05

* Including a small quantity at $8.00.

Quantities of concrete in

Floors	5,479 cu. yds.	49%
Walls	861 cu. yds.	8%
Columns	366 cu. yds.	3%
Roof	4,345 cu. yds.	39%
Miscellaneous	107 cu. yds.	1%
Total	11,158 cu. yds.	100%

The labor cost of mixing and placing was $1.71 1-3, fuel 12 cts. and miscellaneous hardware, steel and repairs 29 cts. per cu. yd.

Reinforcing Steel

The distribution of steel bars was as follows:

Floor...	124 tons	—0.34% by volume of concrete
Walls..	47 tons	—0.83% by volume of concrete
Col'ns..	31 tons	—1.28% by volume of concrete
Roof...	255 tons	—0.89% by volume of concrete
Misc...	7 tons	—0.94% by volume of concrete
Total.	464 tons	—0.63% by volume of concrete

placed at a cost of $15 per ton.

Hand grading and tamping preparatory to laying floor cost the contractor $1.50 per 100 sq. ft.

Constructing the Floor Arches

The floor is formed by a series of parabolic groined arches having a rise of 18 ins. on a span of 15 ft. 8 ins., a minimum thickness of 9 ins. and a maximum thickness of 27 ins. at the columns. The column base is 28 ins. square. In construction the floor was divided into two parts; the lower 4 ins. was laid first as a mat, reinforced with ½-in. square twisted bars spaced 12 ins. centers in two directions; this mat served the double purpose of a waterproof membrane and as the foundation for the groined-arch upper floor section.

In forming the parabolic floor section unit metal frames were employed whose arrises were made of heavy steel tees supported upon rectangular wooden frames. Eight of these frames were made, each being used over 50 times. The concrete was troweled smooth by working cement to the surface.

The cost of setting the floor screeds 420 times was $1.02½ each.

Contractor's superintendence, field-office and bond expense are not included in unit costs quoted, but they do include whatever profits were realized by the contractor.

The Roof Slab

The roof slab is 9 ins. thick, having drop panels at the column heads 6 ft. 6 in. square extending 5½ ins. below the bottom of the slab. The reinforcement was from billet stock rolled into deformed bars and stressed under the assumed leading to 16,000 lbs. per square inch.

The columns and column heads are circular and were formed by special metal forms rented by the contractor.

Columns and Walls

The cost of setting the 420 column forms was $2.03½ each; the rental of column forms sufficient to form 10 per cent of the columns at once and the purchase of floor screeds distributed over 420 columns amounted to $6.32 each.

The walls are 15 ins. thick and rest upon a footing 9 ins. thick extending 12 ins. outside of outer wall line, the vertical reinforcement having its anchorage in the floor and roof slabs. The walls at the corners of the reservoir are curved to a radius of 10 ft., this expedient having been found successful in the elimination of contraction cracks at points where such cracks are usually found troublesome.

Reinforcement for temperature stresses in the walls consisted of ⅝-in. round deformed bars spaced 12 ins. centers in each face.

Forms

The form lumber necessary to construct 18 per cent of the wall length and 15 per cent of the roof surface including supports for 27 per cent of the roof surface distributed over the entire surface formed amounted to 5 cts. per sq. ft. The cost of forming labor for roof surface was 11½ cts. per sq. ft. and the cost of wall surface $5\frac{7}{10}$ cts. per sq. ft.

The roof forms consisted of a series of bents or trussed units made from 2x8-in. planks doubled which were spaced 3½ ft. centers and lagged with 2x8-in. planks. These bents were erected upon wedges. At the center point of each panel between columns a 4x6-in. prop was left standing for 7 days after the centers had been struck. The drop panels around columns were made of wooden units in two sections and were used about 7 times.

Wall forms were made in unit sections each 4 ft. wide using ⅞-in. tongue and groove sheathing placed vertically, reinforced by 2x6-in. ribs placed logitudinally and with wood flanges at the sides for belting the sections together; 4x6-in. horizontal walings spaced 24 in. centers were bolted through the wall at intervals of 30 ins. by ⅜-in. round rods held by set screw clamps; these rods were left in place after the removal of forms and the ends burned off flush with the wall and plastered with pitch.

Construction Equipment

The contractor's equipment consisted of one 18 cu. ft. Koehring Mixer mounted upon a platform forming the base of a tower 74 ft .high and located beneath a charging hopper or bin holding 45 cu. yds. of gravel, the tower supporting one concrete chute 30 ft. long and two counterbalanced chutes, one 40 ft. and one 50 ft. long, giving a working radius of 120 ft. This apparatus was mounted upon rollers for convenience in moving. The chute system was manipulated from a 70-ft. boom attached to the base of the tower and the elevating bucket operated by a Byers single drum hoisting engine. The

hopper was charged by means of a Clyde 2-drum hoisting engine mounted upon a stiff leg derrick mounted upon rollers and having a 70-ft. boom and ¾-yard clam bucket.

In addition to this outfit the contractor used a Jaeger ½-sack batch mixer for placing floor concrete.

Construction Methods

The larger mixing plant was first placed in the center of one end of the structure and was moved eight times down the center to the opposite end, finishing floor, walls and roof as the derricks were moved along. Day-joints were properly bulkheaded and keyways left in all bulkheads. Immediately upon the completion of one portion of the roof the margins of the day's work were dammed with a small mortar edging and water about 1½ ins. deep was permitted to fill the enclosure; this procedure resulted in eliminating surface checks by keeping the fresh concrete saturated and also tended to keep the temperature of the concrete from rising during the hot days of mid-summer. No expansion joints were provided, dependence being placed upon the steel bars, keyways and the density of the concrete mixture to produce a monolithic and waterproof structure. The centers were removed seven days after pouring a section of roof slab leaving, however, one 4x6-in. prop in the center of each span between columns in two directions. In seven days more these props were removed and in two more weeks, or 30 days from date of pouring, the earth fill was distributed over the roof in layers 7 to 10 ins. deep. It must be borne in mind in this connection that the work was practically done in midsummer when weather conditions for curing the concrete were most favorable.

The roof surface was smoothed with wood floats. Bar spacers to properly align and space the reinforcing bars were employed throughout using metal high chairs at the column heads to maintain the steel in its proper position. Eight manholes and four ventiators are provided for ready access and ventilation.

The reservoir is divided into three passes by two baffle walls which provide for the uniform circulation of water through all parts of the basin; they are constructed of 4-in. brick walls joining columns and extend to the column heads, the walls being reinforced at the middle point of each panel by a 12-in. square brick column; 60,000 bricks were used in these walls.

Piping connections are provided so that water may enter or leave the reservoir at three points. One of these connections communicates with an adjoining reservoir of less capacity through a controlling chamber having a drain connection by means of which either reservoir may be emptied and cleaned independently. Another of these connections enters a sump or suction well making practically the entire contents of the reservoir available to the pumps. Pipe connections are 48-in. diameter.

The structure is an excellent example of good workmanship in concrete and the Water Company has every reason to be gratified by the able and efficient manner in which the work was handled by the contractors.

Piping connections were completed and the reservoir tested and placed in service in January, 1922.

Acknowledgment is made to the Mead Construction Co., Indianapolis, for the cost data furnished; to B. J. T. Jeup, Chief Engineer, Indianapolis Water Company, under whose direction the work was executed, and to Leonard Metcalf, Consulting Engineer, Boston, for helpful suggestions.

The foregoing paper was presented by Mr. Mabee before the annual convention of the Indiana Sanitary and Water Supply Association, held in Indianapolis, March 22 and 23, 1922.

DISCUSSION OF THE CENTRALIZED SOFTENING OF A PUBLIC WATER SUPPLY

(Editor's Note:—The following letter from Mr. George A. Johnson is supplementary to the Symposium on the Centralized Softening of a Public Water Supply, published on pages 103-108 of the March, 1922, issue of Municipal and County Engineering.)

To the Editor:

Relative to water softening, I may say that I have some very pronounced views on that subject, coming from rather intimate contact with a number of problems involving correction of chemical imperfections of water. Replying to your questions seriatim:

1. I do, unqualifiedly, consider it economically feasible to soften an entire public water supply at a central point before it is distributed to the consumers; and that it is vastly more economical in the case of the average water taker to proceed in this manner than to attempt such

softening on the premises of the individual householder.

2. With regard to whether the above may be made to apply to the industrial as well as to the domestic consumer, I am of the opinion that it most assuredly can.

3. I do believe that centralized water softening is economically feasible.

In more detailed explanation of the foregoing expressions I would point out that water softening is a real art, requiring primarily a clear understanding of the conditions to be met, knowledge of the principles involved in the proper corrective process, proper design of the softening works, and, finally and most important of all, competent and faithful performance on the part of the operating staff. In addition to all these, and particularly in cases wherein the corrective process lime and soda are employed, adequate appropriations must be made, and continue to be made, for the purchase of such supplies.

Paradoxically enough, municipal water softening, while economical in the end, is a relatively expensive undertaking. If the process involves the use of lime and soda its cost is proportional to the hardness of the raw water. In a lesser measure the same thing is true where softening is effected by the use of zeolites, true or artificial. The obvious thing to do is first to educate the public in the benefits which will follow the softening of its water supply to a given definite point, and then make suitable financial provision in the annual budget so that the ideal thus set will in the future be always realized. Once give a community formerly accustomed to a very hard water a water supply possessing a 100-part hardness, and thereafter attempt to exercise economy in the use of softening chemicals resulting in a water of 125 parts hardness and the uproar of protest will be immediate.

There are two practical methods of reducing the natural hardness of a public water supply. One is by the addition to such water of lime to remove calcium and magnesium carbonates, and soda for the removal of the sulphates, chlorides or nitrates of lime and magnesium. Furthermore, in this process it does not seem feasible or possible to completely soften a water, but that some 35 parts per million of alkalinity will remain after complete lime treatment has been employed; and as regards the reduction of the sulphate hardness the necessary use of soda, which constitutes one of the chief items of expense in softening a selenitic water, makes it advisable to restrict such softening to the limit indicated by the benefits to be derived from it.

In the lime and soda process, perhaps best exemplified in the water works at Columbus, Ohio, the chief difficulty lies in always getting a uniform application of the correcting chemicals to the raw water. Cold temperatures slow up the softening reactions, and certain mechanical features of operation must be adjusted with a considerable degree of nicety in order always to obtain the desired results. Residual causticity, always a highly undesirable and frequently troublesome factor springing from chemical overdosing, low water temperatures, inadequate mixing and agitation, etc., is one of the objectionable features of the lime and soda process, and is a potential possibility in proportion to the completeness with which water softening is attempted.

This softening process must always be followed by sedimentation, and usually by filtration as well. It is not economical to forego a suitable period of sedimentation prior to filtration for the reason that one essential of the process is to maintain in suspension the precipitating salts (hardness) during the softening period. To apply such water to filters direct would result in their speedy clogging. Usually before filtration a sedimentation period of several hours is required in order effectively to guard against incomplete softening in the reaction period, to overcome uncertain factors introduced by cold weather conditions specifically as regards retardation of the softening action, and the undesirable effect produced by possible after-reactions. These relate to the very undesirable feature so often noted of the deposition of slow-forming precipitates upon valves, boiler water condensers, in service pipes, etc.

By and large, however, the lime and soda process, in a system properly conceived, designed, built and competently operated, and when followed by a suitable period of sedimentation in turn followed by efficient filtration, will efficiently and reliably reduce the initial hardness of water to practically any desired point, and a clear, innocuous effluent be delivered into the mains. Nevertheless, it must be pointed out that chemical accumulations rapidly form about the individual sand grains in filters treating such waters, and unless the sand is relieved of these coatings at suitably frequent intervals the filter becomes a mere strainer, and a poor one at that. Then, if chemical

precipitations pass over from the sedimentation basins, as they frequently will, the filters will arrest but a part of them and the rest go forward into the pipe distribution systems of the city. It is furthermore to be admitted that some of the precipitated or precipitating salts will enter the mains in any event, which of course is an undesirable feature of this process .

In some places troubles of this kind are more prevalent than in others, but they usually arise from softening plants of inadequate size, improper design or faulty operation. With proper attention paid to these features such troubles can be reduced to a practical minimum. In this event the benefits of the soft water far outweigh any difficulties experienced from deposits in the mains, service pipes, etc., including the cost of their periodic correction. The necessity of fresh (rain) water cisterns with their accompanying pumps, screens to prevent mosquito breeding, etc., are eliminated; there is an enormous soap saving in the laundry and kitchen; the life of delicate fabrics washed in the softer water is materially lengthened; the cost for boiler compounds is cut to a minimum and abnormal drain on the coal pile ceases; and generally the water supply is made more attractive and satisfactory both to the domestic and the industrial user.

The other form of water softening not yet referred to is that whereby through the passage of a hard water through a bed of insoluble sodium—aluminate—silicate the calcium and magnesium salts naturally dissolved in the water under treatment, and which make it hard, are extracted from the water by the exchange for them of the sodium base of the filtering medium. (Permutation.) The exchange silicate takes up the calcium and magnesium and gives a corresponding amount of sodium to the water. Water with a practically zero hardness results. To rejuvenate the filter it is periodically flushed with common salt solution after which it is ready for use again, having been thus restored to its original condition.

The advantage of this process over the lime-soda method of water softening lies particularly in the fact that its operation to give satisfactory results is mostly a matter of manipulation of mechanical parts. There is no necessity of carefully gauging the dose of the chemical, for no chemicals are used, the filtering medium (exchange silicates) doing the same work and actually accomplishing a better and more complete and reliable result in its own peculiar way. Furthermore, there can be no residual causticity, as is always the case with plants employing the lime-soda process, nor after-precoipitation in mains, service pipes, etc. If the raw water contains mud or other impurities, such matters are removed by suitable pretreatment and filtration before softening is undertaken.

In conclusion, I can answer your three questions, as set forth at the beginning of this communication, in the affirmative. Why municipalities will continue to force their citizens to waste soap to soften hard water; money to support the troublesome rain water cistern supply; abnormal amounts of coal to raise steam in badly incrusted boilers; coal waste again, to provide the increased pressures required to force the municipal supply through hardness-incrusted mains, etc., etc., is hard to explain. The average city of this country provides a satisfactory water supply as regards hygienic purity, but the same city has failed to date to take proper account of the hardness of the water. It is no extravagance of statement to say that unquestionably scores of cities in America would profit in a really big way by adopting water softening for their municipal supplies. It is certain that in numerous places the collective citizenry and industries are spending each year many times the cost of centralized water softening; and not only that, they are doing an imperfect job of it in most instances, and all around a far less satisfactory job than could be effected in centralized municipal water softening plants.

Very truly yours,

George A. Johnson,
Consulting Engineer.

150 Nassau St., New York, N. Y.
March 30, 1922.

EXPERIENCE IN CENTRALIZED WATER SOFTENING IN McKEESPORT, PA., MUSKOGEE, OKLA., AND GEORGETOWN, KY.

(Editor's Note: Mr. Alexander Potter, whose experience with and observation of centralized water softening has extended over a considerable period of years, has written us the following letter, discussing the subject.)

To the Editor:

The writer bases his answers to the questions put to him largely on his per-

sonal experiences with the plants designed and constructed by him for the cities of McKeesport, Pa., Muskogee, Okla., and Georgetown, Ky. All of these plants have been in operation for periods ranging from 10 to 15 years and so far as he knows are giving satisfactory results.

When the plant was put in service at McKeesport in 1908, local conditions compelled the use of the Youghlegany River, a stream highly polluted with mine drainage from the soft coal regions above and also from the pickling waters of galvanizing works.

It is not only economically feasible to soften an entire supply from a central station, but there are distinct savings in the light of results actually obtained. Perhaps an individual might consider that he is running his private softener at a cheaper cost to himself, but this is a rare condition. An examination and a close comparison will almost invariably show that he is not getting the uniformity of results which are possible at a central plant where the attendant is keeping constant watch of the condition of his raw water and varying his chemicals accordingly.

Such close control is certainly not practicable in a private plant although in large industrial plants it certainly pays to watch the variations in the raw water equally as well as it does in the average municipal plant.

What hope for success is possible in a small private plant where, for instance, at McKeesport, the writer has known the hardness to jump from 110 to 510 parts per million in a single day? Regulation is practically impossible in a private plant under such conditions.

During the war the price of soda ash jumped to such figures and the material was so hard to procure that the City of McKeesport changed over its source of supply to the very much less acid polluted water of the Monongahela.

The softening process used will depend largely on the composition of the raw water. For a highly acidulated water like the Youghlegany at McKeesport, the acids must first be neutralized by soda ash, and lime afterward applied. For waters hardened by contact with limestone, lime alone will suffice. Excellent results are obtained by the use of permutit.

The writer has had very little trouble with the clogging of service mains or fixtures, where the $CaCO_3$ is fully dissolved. The application of the lime in the form of lime water is the true solution for softening. The writer has recently inquired into the conditions at McKeesport, and finds that there has been a remarkable freedom from clogging of the services and none whatever of the mains. In fact, just before the softening plant was constructed, the city was negotiating a contract for the cleaning of the mains through the city, but the softened water was admitted to the mains but a very short time before the mains were entirely free from deposit.

At McKeesport the softening is followed by mechanical filtration and it has become necessary to remove the sand once in eight years, the experience with the accretion of sand grains following along the lines indicated at other places. The loss of sand in washing, due to the accretions, has been found to be more than compensated for by the fact that the lime retained in the sand beds did not pass on through the piping system and into the plumbing and fixtures.

As the writer views it, the essentials to a successful softening of the water are:

(1) Complete solution of the chemicals.
(2) A thoroughly baffled mixing chamber or equivalent mechanical agitation.
(3) An adequate period of sedimentation in a basin with a perforated bottom to insure at all times the full settling capacity of the tanks by blowing off the sludge daily or at less intervals without emptying the tanks.

Very truly yours,

ALEXANDER POTTER,
Consulting Engineer.

Mar. 28, 1922. Plaza Hotel, Havana, Cuba.

FIRE SERVICE AS IT RELATES TO WATER SUPPLY

By Daw R. Gwinn, President and Manager, The Terre Haute Water Works Co., Terre Haute, Ind.

It goes without the saying that there must first of all be an ample water supply with reserve pumps, boilers, etc., and if the water must be purified, reserve filter capacity over and above the ordinary domestic demand.

Next, the distribution system must be large enough in diameter and sufficient in length to reach the built-up portions of the territory to be protected. The man who builds at a considerable distance from water mains is taking a risk and until the section is reasonably well built-

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up, he will have only such fire protection as long lines of hose to the nearest hydrants will furnish. When there are still thousands of vacant lots with water and other utility service in a community, the man who builds out where houses are few and far between cannot expect water, gas, sewer and electric service.

Quantity of Water Required

As to the quantity of water necessary for fire purposes, I will quote from a report on Terre Haute by the committee on fire prevention of the National Board of Fire Underwriters:

"Protection.—Reasonable protection for the principal mercantile district requires a fire flow in excess of maximum domestic consumption of 6,500 gals. per minute, with a system of mains capable of delivering this amount about any block and hydrants so located as to deliver two-thirds of the quantity upon any large fire through hose lines, none exceeding 500 ft. in length; the total quantity includes an allowance for losses from broken services, elevator and sprinkler connections incidental to a large fire and should be available at pressures sufficient to give direct hydrant streams. In warehouses, manufacturing and minor mercantile districts, 3,000 to 4,000 gals. per minute are necessary, and in residential districts from 1,500 to 3,000 gals."

Care of Fire Hydrants

In the care of fire hydrants, it may be best to state the methods used at Terre Haute:

1. For a number of years it has been our policy to use 6-in. branch connections to hydrants with a 6-in. Gate Valve on the same, so that repairs may be made without shutting off the main line and possibly other hydrants.

2. All fire hydrants have brick drain pits at the base, opposite the drain openings. These pits are open at the bottom and are about 1 cu. ft. capacity. They facilitate the quick draining of the hydrants.

3. Hydrants are flushed in the Spring and Autumn—usually in April and September. This is for the double purpose of cleaning the distribution system and for examination of hydrants—to determine if they are in good working order. On the occasion of a recent flushing, two hydrants were found to be broken below the surface of the ground; there was nothing in their appearance that would indicate that they were broken. In the past two years, we have had about 20 fire hydrants broken by automobiles. In a number of cases the broken hydrant stocks were welded at a cost of about $8 each. A record is made of hydrants that are hard to open, those that do not drain, that leak through the waste when open fully, and any that require attention. These are attended to promptly. All our fire hydrants open by turning to the left. We have a hydrant with a portion of the stock and front case cut away; this is used to show the firemen how a hydrant is operated.

4. Inspections are made just before Winter begins and the most important hydrants are inspected from time to time during very cold weather. This is done by removing the nozzle cap and dropping into the hydrant a weight attached to a cord. Notwithstanding our repeated inspections, we occasionally find a hydrant with water in it, due to ground water getting in through the drain opening or through a small leak in the main valve.

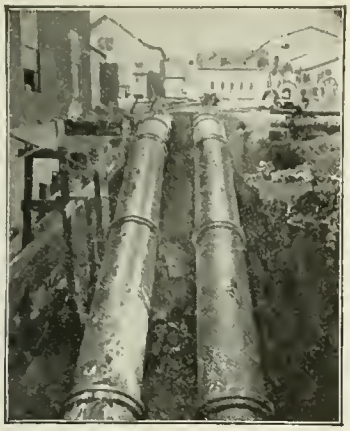
5. We carry in stock hydrants of different sizes and makes and these are substituted for those that are out of order. By this plan, the hydrants are available promptly for the Fire Department and we repair the removed hydrants when convenient.

6. If a hydrant should be found with ice in it, salt and hot water are used for thawing.

7. The Fire Chief is notified immediately when a hydrant is found out of order, due to being broken by automobiles or to freezing; also whenever it is necessary to shut off a main line. This information is sent by the Chief to the different fire houses. When a hydrant is restored to service, the Chief is notified.

8. Fire hydrants are for extinguishing fires and as far as possible should be kept sacred for that purpose. When water is needed by the city for flushing a sewer, we are notified and our man goes out, attaches an auxiliary valve on one of the nozzles and then opens the hydrant full. The City men use the auxiliary valve and when through with the water, they telephone our office and our man closes the hydrant and removes the auxiliary valve. No charge is made for the water or for the time. When water is furnished for a circus or to a contractor from a fire hydrant, we use auxiliary valves, but our man remains on the ground and we are paid for his time as well as the water.

9. When a fire alarm is received, a record is made of it and one of our inspectors is given an order to examine the hydrants that are used and report on their condition.



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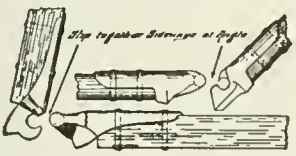

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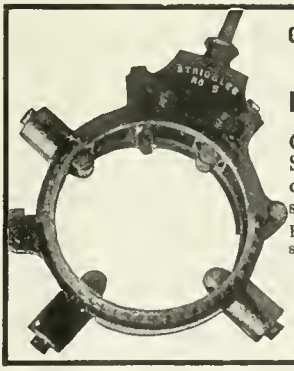

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10. A copy of the Fire Alarm Record, which is the order for inspecting hydrants after they have been used by the Fire Department, is shown herewith:

Fire Alarm Record

Date.....191.....
Location of fire.....
Alarm received (time).....
Alarm received by .....
Box No.....By A. D. T. No.....
Average fire pressure, outlet of filters.....
.....Pounds
From.....M. to.....M.
Time of receiving second alarm.....M.
Notified Mr. .....at .....M.
Notified Mr. .....at .....M.
Notified Mr. .....at .....M.
Notified Office, Mr.....at.....M.
Strike out signal received.....M.
Strike out signal received by.....
Pumpage rate, No. 7.....No. 5.....
No. 4.....Total Rate.....
Remarks .....
.....
.....
.....

OVER

RECORD OF FIRE HYDRANTS USED.

Character of Fire, Etc., Etc.
Hydrants used and condition after fire.
Location Condition
.....
.....
.....
.....
.....
.....
.....
.....
Remarks .....
.....
.....
Inspection made this.....day of
.....19.....
.....
Inspector.
Fire Loss $.....

Gate Valves

Our policy is to reduce the size of the districts and as we have an opportunity, we set additional valves. In the outskirts we endeavor to make districts 750 to 1,250 ft. in length. With valves on fire hydrant branches, it is seldom necessary to shut off a district. Valves are located on the property line, or within 1 ft. of the line. This is a help in finding them. On paved streets, we build a brick well or pit around the valve.

About two years ago we abandoned the plan of using gray iron covers and are now using malleable iron covers. This change was made on account of the breaking of gray iron covers by heavily loaded trucks. Municipal and County Engineering published a paper on this subject in the February, 1922, issue.

We try to examine all valves in the distribution system (except those on hydrant branches) annually. The valves are closed and opened to determine if they work freely. In most cases, we find that the cause of a valve operating hard is in the gland on the stuffing box, due to corrosion. This can be remedied by scraping with the blade of a pocket knife.

We have a skeleton map of our pipe system with tracing from which blue prints are made, drawn to approximate scale of 1,000 ft. to the inch. The skeleton map for our 104 miles of mains is 30x21 ins. and folds up in a loose leaf binder 4½x7 ins. outside measurement. Each valve on the main lines is shown by a short right angle dash and bears a number at the side. Locations of the valves are shown opposite a corresponding number on sheets 4x6⅞ ins., which are placed in the loose leaf binder along with the blue print map. The headings are, Valve No.—Size—Looks—Turns—Box Well—Make—Ft.—In.—of—Prop. Line—Ft.—In.—of Prop. line. As only one line is used for each valve, 15 locations are provided on each sheet. By reference to the map, it is readily seen what valves are necessary to shut off a district and the exast locations are found on the sheets by looking up the corresponding numbers. One heading is sufficient if pasted on the inside of the left hand cover. The locations may be made on a typewriter, making manifold copies for extra books, or they may be printed on tracing cloth for blue printing. We have also photographed the tracing cloth drawings and thus were able to make smaller books. Every man who has occasion to shut off main valves carries one of these books with him.

Our men are instructed to report on their work order just what valves they have closed, giving the date and hour when closed and when opened.

We carry in stock for making repairs, complete valves except the body or lower casting, of the different makes of valves, so that when a valve is out of order, it can be repaired quickly. All valves in the distribution system close by turning to the left.

Effect of Raising Fire Pressure

This subject is receiving a good deal of attention just now, owing perhaps to the splendid development of motor pumpers and also to the realization of the danger of broken mains when high pressure is applied. It may be of interest to give a copy of the resolution which was adopted unanimously in November, 1921, at the Convention of the Iowa Section of the American Water Works Association. It was as follows:

"Whereas, There are serious objections to the practice of raising water pressure on systems of water mains at time of fire, and

"Whereas, The increase of pressure in

itself results in more water being discharged through the numerous leaks, which always exist, and more water being used through fixtures, damage to plumbing, in the breaking of service pipes, and, at times, the breaking of large mains; all at a time when the whole water supply should be strictly conserved, and

"Whereas, accidents to pumping machinery and valves are more apt to occur, and do occur, under the additional strain and during the excitement of raising fire pressure: also increased pressure ordinarily requires that water stored in elevated reservoirs is not available because of being shut off to permit direct pumping into the mains, so that at such times an extra strain is placed upon filter plants and there is consequent danger of epidemic following a conflagration, and

"Whereas, in handling fires in high buildings, and in the case of other serious hazards, fire departments now require large and powerful streams far beyond the capacity of domestic water works systems to supply, and

"Whereas, such streams can be furnished by motor pumpers which are well adapted to this requirement and make shorter and more lines of hose available without the heavy expense for equipment and operation which was formerly required in the case of steam fire engines,

"Therefore, Be It Resolved, by the Iowa Section of the American Water Works Association in convention at Omaha, that we recognize the hazard and expense incurred in raising fire pressure in domestic water mains and we declare it is our opinion that this is undesirable practice and that such method of producing fire pressure should be supplanted as rapidly as may be by motor pumpers or other auxiliary apparatus as being more suitable, more economical and in the best interest of the whole people."

The resolution was prepared by Mr. Charles R. Henderson, Manager of the Davenport (Iowa) Water Co., and a Past President of the American Water Works Association. Mr. Henderson is one of the best posted, most wide-awake and most efficient water works managers in the country. His views are valuable because he is so thorough. Therefore, when Mr. Henderson advocates a method of doing things, I believe there must be merit in it.

In a recent number of Fire & Water Engineering there appeared an interesting article from one who has served as a fireman. The author was Sherwood B. Brockwell, ex-chief of the Raleigh, N. C., fire department, now Safety Engineer, North Carolina Insurance Department. Mr. Brockwell is a graduate engineer and presented his views before the North Carolina Section of the American Water Works Association. The headlines were as follows:

"FIRE ENGINES BETTER THAN DIRECT PRESSURE."

"They and larger mains, according to this well-informed author, are the necessities for proper fire protection."

Extracts from Mr. Brockwell's paper:

"The time has now come when it is no longer necessary for water works engineers to try to combine the functions of a water works system and fire apparatus. * * * The fire chief is, during the time of a fire of any consequence, up against two propositions neither of which will help him any—low pressure fire streams or the entire system under an undue strain and even with the direct pressure, subjecting, as it does, all mains, pipes, appliances and machinery to rupture, the chief could not get a standard fire stream from a third line of hose in the uptown or congested district. * * *

"Very few people not trained in fire fighting know the value of this third stream. * * * The first company arriving attaches to the nearest hydrant and the men at the nozzle attempt to reach the heart of the fire. The second company to arrive attaches to the next nearest hydrant and attacks the fire at a point where it seems most likely to spread. The chief, as a rule, arrives while these two lines are being stretched and the third line is invariably his engineering line. The two nearest hydrants are being used so this third line is stretched from the hydrant on the next corner. Now what does that mean? * * *

"Say he gets away with 600 ft. or 12 sections of hose and a 20 ft. elevation —starting with the maximum pressure of 125 lbs., two streams already flowing, this third stream reaching him through 600 ft. of hose and elevated to 20 ft.—Messrs. Freeman and Ellis will tell you what kind of a stream he gets—it would not be apropos to use the fire chief's language in a meeting of this kind. Suffice to say with 125 lbs. pressure he cannot get a fire stream and over 125 lbs. on the mains would be the height of indiscretion.

"As a fireman talking to engineers whose opinions are taken above the fire

chief's in matters of this kind and far too often above that of the superintendent of water works, by the average city council, I urge you gentlemen seriously to consider confining your efforts in fire protection to supplying the volume of good water in sufficient sized mains and then impressing upon the city councils the necessity of providing the necessary fire apparatus with which to convert this volume into effective fire stream."

The danger of having broken mains due to high pressure and jeopardizing the fire service is real. Some years ago, during a factory fire in Terre Haute, a 6 in. main was broken at a point near the fire. The result was a serious drop in the pressure, as the line was supplied from both ends, one being a 16 in. line about 70 ft. distant. It took probably an hour to shut off the district. The ground was frozen and some of the boxes were covered with ice.

If there had been another fire in the high hazard district when the broken main was discharging large quantities of water, it would have been impossible to furnish proper fire pressure and the results might have been a serious conflagration.

Another point should be considered in connection with raising fire pressure—that is the breaking of service pipes and leaks through water closets. In Terre Haute, at fires where the pressure is raised, but where no water is used, not a single hydrant being opened, the pumpage is increased at the rate of two million gallons per day. Many water closets are adjusted to the normal domestic pressure and when the pressure is increased, the closets start to run and probably continue to run for some time. Every small leak discharges more water when the pressure is increased.

This means that there is two million gallons capacity that is not available for fire purposes. It also means where the service is on the meter basis, increased consumption recorded by the meters with consequent increase in payments by private consumers. If only the normal domestic pressure was maintained, the leaks in water closets and service pipes would be materially reduced and the danger of broken mains when water was needed for fire service would be reduced to the minimum.

The foregoing paper by Mr. Gwinn was presented at the recent annual meeting of the Indiana Sanitary and Water Supply Association.

THE ABUSE OF SANITARY SEWER SYSTEMS

By J. A. Stewart, Civil Engineer, 1309 Traction Bldg., Cincinnati, Ohio.

Unjust criticisms of sanitary sewerage systems by the public (especially residents of the smaller incorporated villages and towns) has caused many smaller communities to delay the installing of proper facilities for the disposal of sewage for many years until their financial condition would permit them to construct a combined system. The result being that the small streams, dry ravines and even street gutters and roadway ditches are polluted with sewage, the overflow from cess-pools not properly constructed or cared for, which oftimes causes epidemics. This could have been avoided by the construction of a strictly sanitary system, the cost of which would not have exceeded their assessment and taxing limitations.

The complaints of the inadequacy of the sanitary system can only be attributed to the misunderstanding of the fundamental principles of sanitary engineering.

It is not the system but the inexcusable abuse of it by property owners, municipal employees and plumbers that cause this unjust criticism by the general public.

The prime object of the system is to provide for the sanitary flow with a reasonable allowance for ground-water. The size of the conduits can be calculated to within an error of approximately 10%.

In my investigations of many sanitary systems I have not discovered one that was taxed to one-half of its capacity in dry weather, but they were all overloaded during heavy rainfalls, proving conclusively, that the supervising officials had permitted the connection of roof water leaders with the sanitary sewers, although there was an ordinance in force at the time in the city or village strictly forbidding such connections.

I have found many instances where the employees have actually connected inlets and catch basins with the sanitary sewer, expecting the small pipe to carry off the storm water flow. This of course resulted in flooded cellars at various points in the system and furnished plausible arguments against the system for property owners who did not realize that the trouble had been calsed by the abuse of the system by employees and officials of the municipality.

The attention of municipal officials, plumbers and the general public should be called to the abuses, and their co-operation in the proper use, care and maintenance of the system secured.

EXPERIENCE WITH THE CITY MANAGER PLAN

By Robert E. McDonnell, Consulting Engineer, Interstate Bldg., Kansas City, Mo.

How is the City Manager form of government working out in actual practice? The inquiries sent out to cities by the Chamber of Commerce of Sacramento, Cal., brought the following replies from prominent authorities outside the City Government.

Akron, Ohio—"Since the establishment of the City Manager form of government definite results showing the value of centralized administrative power in the hands of an expert, have been achieved."

Grand Rapids, Mich.—"It has resulted in economy in City Affairs with increased efficiency, and the people appear to feel satisfied that it is a great improvement."

Norfolk, Va.—"Its superior efficiency is so generally recognized that under no circumstances would we return to the former system. Wonders have been worked in Norfolk since the City Manager form of government was inaugurated. It has the enthusiastic support of the people of this city. Norfolk saved $100,000 of its annual budget the first half of its present fiscal year."

Wichita, Kas.—"It is an ideal business form of government as it carries out all the sound, well-established principles that govern private business."

Phoenix, Ariz.—"I am sure that you could not get a business man in Phoenix to go back to the old style of government."

Springfield, Ohio—"The City Manager plan has given Springfield more for the taxes paid than ever before.

Wheeling, W. Va.—"The City Manager plan has been successful in every way in Wheeling. It has met expectations and is giving efficient government."

There are now 5 cities of more than 100,000 population successfully using the City Manager plan: Akron, 208,000; Dayton, 154,000; Grand Rapids, 138,000; Nashville, 118,000; Norfolk, 116,000, and Cleveland with 800,000 or more than twice the size of Kansas City, adopted it recently with 17,000 majority.

Will it work in the larger cities? We do not wish to admit that because of our size we should be content or satisfied with a less efficient plan of government than exists in smaller cities.

The principles involved in the government of large cities are identical with those of smaller municipalities. The manager plan has worked best in the larger cities. The administration becomes more impersonal. The funds available in larger cities make it possible to secure better experts as heads of departments. Specialists can be secured for investigating water supply, sewerage and garbage problems. Experience of City Managers proves that success is easier in the larger cities.

From the standpoint of an engineer, having for 25 years served as expert in municipal problems, to over 400 cities, 27 of the 400 being city managed, I can unhesitatingly state that it is by far the best plan of City Government yet devised and its growth by leaps and bounds is fully justified.

In conclusion, the 12 years' working of City Manager cities shows it is a plan far superior to anything heretofore tried. Perfection is not claimed for it, but its weak features are rapidly being eliminated and much of the success accomplished is due to the greater human interest taken by the citizens in a form of government in which the people have a voice and can see the good results.

The foregoing is from an address by Mr. McDonnell before the Kansas City Council of Clubs, an organization representing 63 civic clubs in Kansas City.

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Construction News and Equipment

FURTHER SIMPLIFICATION OF PAVING BRICK VARIETIES

Four months ago there were 66 types and sizes of vitrified paving brick being manufactured throughout the United States, specified by engineers and used in paving streets and highways. Today there are only seven recognized types and sizes.

This elimination comes about as the result of co-operative action on the part of engineers representing the principal national engineering organizations, the Bureau of Simplified Practice of the U. S. Department of Commerce, and representatives of the paving brick manufacturers of the United States. It comprises the first concrete results of Secretary Herbert Hoover's campaign to eliminate waste in industry by eliminating excess and needless varieties.

At the first meeting of representative producers and buyers, held Nov. 15, 1921 in Washington, only 11 of the 66 types and sizes were retained. At that time a permanent committee was appointed to consider further eliminations and to influence the general acceptance of the recognized types and sizes.

The permanent committee held its first meeting in Washington, March 27, 1922. The committee was informed that the following organizations already had formally approved the first eliminations: National Paving Brick Manufacturers Association; American Association of State Highway Officials; American Institute of Architects; American Ceramics Society, Engineers Club of Columbus; Indiana Engineering Society; Western Society of Engineers; American Society of Civil Engineers; the Departments of Agriculture, Commerce, Interior, Navy and War.

After considering new data as to total shipments of vitrified brick for 1921 the committee voted unanimously to eliminate the following sizes:

Vertical Fiber Lug..... 3x4x8½ in.
Vertical Fiber Lug.... 3½x4x8½ in.
Wire-Cut Lug Hillside.. 3½x4x8½ in.
Repressed Lug .....3½x3½x8½ in.

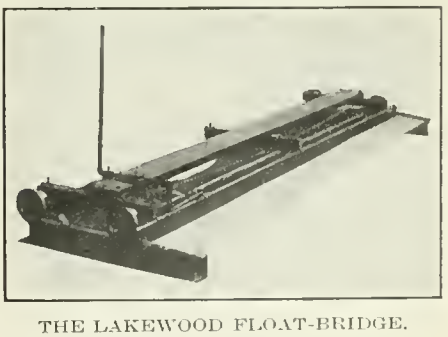
The following remain as the seven recognized types and sizes:

Plain Wire-Cut..... 3x4x8½ in.
Plain Wire-Cut..... 3½x4x8½ in.
Repressed Lug .....3½x4x8½ in.
Wire-Cut Lug..... 3½x4x8½ in.
Wire-Cut Lug..... 3½x3½x8½ in.
Wire-Cut Lug..... 3½x3x8½ in.
Repressed Hillside ....3½x4x8½ in.

The committee decided that with four eliminations it had proceeded as far as was desired until there were further reactions from producers and consumers. It was therefore concluded that no further eliminations would be considered until March-1923 at which time data on 1922 shipments would be available to serve as a guide.

THE LAKEWOOD FLOAT-BRIDGE

The Lakewood Engineering Company, of Cleveland, has brought out a new item of equipment for concrete road construction known as the Lakewood Float-Bridge. This was exhibited at the Chicago Road Show this year and met with approval of both Contractors and Engineers.



THE LAKEWOOD FLOAT-BRIDGE.

The Float-Bridge, as shown by the picture, is exactly what the name implies—a hand operated belt float and substantial bridge combined. One man operates the lever which moves the belt back and forth across the pavement, at the same time automatically advancing the machine a little with each stroke. The traction mechanism can be instantly thrown out of gear so that the Float-Bridge can be

pushed forward or backward. The belt can be raised off the pavement and is automatically held up until released.

On many concrete paving jobs it has been found that a final belting, some little time after the pavement has been struck off, tamped, and surfaced, does much to prevent hair cracks and also gives a better surface. Time does not allow the finishing machine to go back and do this final belting, and it was primarily for this work that the Float-Bridge was developed. It also gives the contractor doing hand finishing a one-man operated belting device.

Another big advantage of the Float-Bridge is that it provides a strong bridge across the road, carried on wheels traveling on the side forms, which is easily moved by one man.

DUMORITE REDUCES BLASTING COSTS

Reports from various parts of the country show that "Dumorite," the new explosive, recently put on the market, is effecting reductions in blasting costs amounting to one-third and more. Statements from users show this is especially true in quarry, farm blasting and other open work, because the new dynamite frequently shoots stick for stick with regular 40 per cent dynamite while at the same time each case contains at least one-third more cartridges.

A quarry company in the Middle West reports that in their operations, Dumorite is materially reducing blasting costs. In eastern quarries, equally good results have been obtained.

Experimental work in stump blasting had already shown that Dumorite was an important money-saver for the farmer. A blaster of Worsham, Virginia, is using it and reports: "I want to advise that I find it as good stick for stick as any 40 per cent dynamite I have ever used and as it has 33 per cent more sticks per case than any 40 per cent dynamite I have ever used, it cut the cost of blasting out stumps just 33 per cent. Besides there was no headache caused from using it and this feature alone appeals to the farmer."

In states where large stumping operations are under way, experience is also showing that the new explosive is a great boon to farmers, since it enables them to make an important slash in blasting costs.

These reports follow out the statements made concerning the explosive at the time it was perfected. The Du Pont Company then announced that "Dumorite" was manufactured on a double base of modified nitroglycerin and guncotton, that it could not freeze and would not produce headache. This last advantage, combined with the saving in blasting costs, is causing it to be regarded as the most advantageous explosive on the market at this time.

IOWA PROCEDURE IN GRAVEL ROAD CONSTRUCTION

By J. F. Reynolds, District Engineer, Iowa State Highway Commission, Storm Lake, Iowa.

One of the first questions that usually comes up in any discussion of gravel roads is the question: "Should we pave or should we gravel?" When we analyze the situation, there is no argument. It is entirely a question of traffic. It would be very poor engineering to pave a road that can be maintained as a gravel road. On the other hand when the traffic becomes so heavy on a road that a good riding surface cannot be maintained with gravel, there is only one thing left to do and that is pave. If this situation was clearly understood by the people of the State of Iowa, the way would then be clear to the harmonious solution of the road question, and we could go forward to better roads, by eliminating arguments and pulling together. Remarks of this kind may appear unnecessary to a gathering of professional engineers, but the fact remains that this question is continually agitated by newspapers, politicians and even by some persons claiming to be engineers, said Mr. Reynolds in addressing the Iowa Engineering Society recently.

A greater advance in the methods used in the construction of gravel roads has been made in the past two years in the State of Iowa than in all previous years put together.

The Gravel

The first thing we consider, of course, is the material available. In judging various gravel deposits, the important screen test is no longer the amount of material retained on a ¼-in. screen, but is more nearly the material retained on a ⅛-in. screen. Gravel passing a ¼-in. screen but retained on a ⅛-in. screen is excellent material. The very best material we could get for gravel road construction would be a material well graded and ranging in size from ⅛-in. to material that will pass a 1½-in. screen.

Clean Gravel

It has long been thought that a certain amount of clay binder was necessary in constructing a gravel road. After observation of roads constructed with both clean gravel and gravel carrying a percentage of clay, I have come to the conclusion that the cleaner the gravel is when it goes onto the road the better road we will have. It is true that clean gravel will not pack as quickly as gravel carrying a percentage of clay, but when it does pack it gives a much better wearing surface and the necessary clay for binding the material is worked up from the subgrade. Looking at it in another way, it is very foolish to pay for hauling clay from the source of supply to the road and to pay for the clay by the cubic yard when there is plenty of this binder material in the subgrade itself. There is only one place where I will consider adding binder to the gravel and that is where a gravel road is being constructed over a

The next thing we consider in a gravel road construction is the subgrade. Of course, it has been long conceded that it is necessary that the subgrade be well drained, but it was only a couple of years ago when practically all counties were depositing gravel on a crowned subgrade and attempting to place the gravel in a position in which they wanted it packed. At present we insist on a level subgrade. The right man can take a 12-ft. blade grader and so shape the road that good shoulder lines are left and the surface is level from shoulder to shoulder.

Placing the Gravel

After the adoption of the flat subgrade we still for some time attempted to place our gravel on this subgrade, just as it is shown on the plans. The result was that traffic would go to the shoulders of the road and would have exceedingly difficult going until the gravel packed. If this gravel was traveled on a sufficient length of time it would apparently pack on the subgrade. This would soon be broken up by heavy traffic and leave the road pitted and full of holes. It was almost impossible to maintain a smooth riding surface on the roads built in this way.

After attempting various methods of placing the gravel we finally came to the one that is now commonly in use. The gravel is deposited in the center of the road and spread out wide enough so that there remains only about an inch of material in the center. The balance of the material is on the shoulders. Under maintenance this material is brought towards the center of the road as fast as the gravel is packed. This leaves a road that at all times during construction is an easy riding road and traffic at no time encounters deep, loose gravel. If the material is brought in from the sides, we have a gravel road that is compacted from the bottom up.

A very common method of determining whether or not the gravel is properly spread is to observe the lines of traffic going over the new construction. If the traffic is all confined to the center of the road it is an indication that the gravel is properly spread because traffic naturally goes to that place in the road where it is easiest to get through.

Another method that is productive of equally good results is to deposit the gravel along the shoulders of the road and spread a small portion towards the center. The center of the road is then built up under traffic just as explained in the first method of spreading.

We have found that the method of constructing gravel road just described gives a road with about the proper amount of crown for this part of Iowa. We find that with the flat crown thus produced that all of our material does not become firmly compacted in the road but there is a film of gravel dusting over the road which makes an excellent protection for the road during heavy traffic. It also gives the maintenance man something to work with. As soon as you see a gravel road with all the loose gravel along the shoulders or going into the side ditches it is a very good indication that the road is constructed with too much crown, and the only method I have found for constructing a road that will not have too much crown shortly after it is finished is the one above outlined.

VALUABLE TRADE LITERATURE

(Copies of this literature may be obtained by writing to this magazine or direct to the manufacturers.)

Street Lighting Fixtures.—Education in the intelligent selection of street lighting fixtures is the purpose of Circular 1642, just issued by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Through its publication, the Westinghouse Company proposes to aid those unfamiliar with street lighting in designating what types of street illumination fixtures are most suitable for conditions under consideration, what the illum-

lnation intensity should be and the correct layout to obtain the best results.

The circular, known as "Westinghouse-Cutter Ornamental Posts and Tops," is written in a style that will appeal to the man with little knowledge of the technical details of illumination. It is profusely illustrated with examples of posts and post tops and representative installations of these fixtures are also shown. The growth of the "City Beautiful" idea and the consequent demand for lighting systems of a more ornamental character, eliminating unsightly overhead equipment, have made this publication both timely and useful.

The major considerations in street lighting design, as pointed out in the circular, are the importance of the installation as a safety measure and the enhancement of abutting property values. These, as well as factors of mechanical and electrical design, have to be taken into account before correct specifications can be prepared to secure an ornamental lighting system suitable to a locality.

The circular announces that engineers and others engaged in the preparation of reports and recommendations, covering a complete ornamental street lighting system suitable to various requirements and insuring a maximum of efficiency combined with aesthetic charm, will have at their disposal the Illuminating Engineering Bureau of the Westinghouse Companies which has been organized to carry on research work at the Illuminating Engineering Laboratories at East Pittsburgh, Pa., Bloomfield, N. J., and South Bend, Ind.

Electrically Controlled Valves.—Describes electrical operation of gate valves in water works systems. Issued by Payne Dean, Ltd., 103 Park Ave., New York City. Maintaining water works valves in operating condition is no longer a handicap. Electrification has solved the problem. Many Dean control installations placed in operation during the past few years are successfully demonstrating the practicability of Dean waterproof standardized valve operating units. The Dean motor unit is as rugged as the valve, and may be installed without shutting down the line. From one or more convenient control stations any valve in the system can be readily and easily operated.

Deep Well Pumps.—This is Catalogue B, illustrating and describing Chippewa Steady Stream Deep-Well Pumps as manufactured by the Chippewa Pump Co., Inc., Chippewa Falls, Wis.

Maintaining Roads and Streets. An instructive 30-page booklet entitled, "Modern Methods for Maintaining Roads and Streets," devoted primarily to the many uses of the Andresen Road Repair Outfit, issued by the manufacturers, Littleford Bros., 460 East Pearl street, Cincinnati, Ohio, also illustrates and describes the Littleford line of tar and asphalt heaters, paving tools, etc.

Sand and Gravel Equipment. Illustrates and describes the excavating, elevating, conveying, crushing, screening and washing equipment used in sand and gravel work. Illustrates plant layouts as well as plant units. An attractive catalog of 60 pages, issued by the Good Roads Machinery Co., Kennett Square, Pa.

Excavator Crane. Pauling & Harnischfeger Co., of Milwaukee, distributed a novel piece of printed matter at the Chicago Good Roads Show. This consisted of 2 discs with an eyelet in the center. The idea back of this novelty was to show why the P. & H. Excavator Crane "8 in 1" machine. By moving the upper disc in a circle the various booms that may be used with the P. & H. appear successively—the standard boom with dragline bucket, boom and grab bucket, with material handling bucket, boom with magnet, boom with backfilling scraper, shovel attachment, skimmer scoop and pile-driving rig. In fact this novelty tells the story without words.

Asphalt Paving Machinery. Folder illustrating and describing the Iroquois line of asphalt paving machinery comprising: mixing plants (portable, semi-portable and stationary), portable steam melting kettles, macadam rollers and tandem roller. Issued by The Barber Asphalt Co., Iroquois Dept., Philadelphia, Pa.

Steel Forms. The Heltzel Steel Form & Iron Company, Warren, Ohio, manufacturers of steel forms for concrete work, are now mailing to all who request it an illustrated comic bulletin entitled, "Steel Forms Talk." In an amusing yet forceful manner the bulletin tells why road contractors should buy Heltzel Steel Forms. Ask for Bulletin 26.

Chimney Losses. Two new bulletins issued by the Uehling Instrument Co., 71 Broadway, New York, entitled, "Magnitude of the Power Plant's Chimney Loss and Relation Between CO2 and Money Wasted Up the Chimney." The subject matter is entirely new and the tables and charts are based on new and representative data.

PAVING TRUNK LINE STREETS

By James C. Blake, Street Commissioner, Worcester, Mass.

To my mind all trunk line streets in cities should be of some kind of permanent paving; and I would say granite block: a 5-in. block on a 5-in. concrete base, grouted, with a 1-in. sand cushion between the base and block.

Granite Block Pavements

Much care should be given to the subgrade to have it properly graded and rolled, to eliminate any soft places, as this part of the work is very essential to a good paving job. It should be given a uniform thickness and a proper mix. The mixture of the base should be 1-3-5, to give the block proper support and to carry the load strain. The thickness of the base should be 5 ins. I would advise the use of a template to make a smooth surface, so that the blocks will lay even and not be up and down, to prevent rocking or moving, when grouted. Also care should be taken to lay the blocks so that the joints do not come opposite each other. In other words, to break the joints properly. This is one of the very important features of good granite block paving. This makes a very smooth pavement.

Great care should be given to the grouting of any block paving, that the joints are properly filled with a mix not too thick, just the right consistency to flow freely and fill every joint from the bottom to top and make a solid bond the full depth of the block. The grout should be a 1 to 1 mix. This is not too rich a mix for good work. Granite block paving done along these lines will wear a lifetime, and I firmly believe that this is the only type of paving that will withstand the heavy truck traffic and load strain that they will be called upon to carry in the next few years, for traffic is increasing rapidly and also the size and weight of load. When one thinks of 18 tons of freight on one truck and the weight of the truck, making a total of about 25 tons passing over our roads and streets, it brings most forcefully to our minds that we must build a heavier, stronger type of paving. Greater care should be given to proper drainage, especially in the rural sections, to prevent frost heaving. John N. Cole, Chairman of the State Department of Public Works,, speaking on roads at a meeting of automobilists in the Hotel Kimball, March 19, 1920, predicted that within 10 years 900 miles of main highways will be built of granite block, 24 ft. wide.

Concrete paving is becoming one of the most popular types of paving that is known for trunk lines, or that portion under State control. Great contracts are being awarded each year, so that at the present time we have miles of this type of paving in every state in the Union. A concrete paving, properly put down, at a proper thickness and with a proper mix, with good drainage and a first-class subgrade, ought to last for many years under the most trying traffic. There are many things entering into the question of paving properly put down: First thickness, uniformity of thickness and mix, width, sub-grade and drainage. The thickness of a good concrete paving should be not less than 10-in., same to be reinforced, although it is a question in my mind as to the essentials of expansion joints. I appreciate the fact that there are many road builders who will differ with me on this particular phase of the question. However, I believe that expansion joints are unessential. Care should be given to the mix, to have it uniform and not to have one batch too wet and the next too dry, for a mix of this kind will not result in a good pavement. Everything going into a good concrete pavement should be measured. Stone aggregate should not be too large. Sand should be clean and sharp so that the mix is right. Care should be given to setting the forms, that they are firm to prevent sagging, using the template to give an even top surface to eliminate waves, etc. The width should be not less than 24 ft., and I would recommend 30 ft. as the proper width, as I think the roads are being built altogether too narrow to take care of the increasing traffic. Roads built ten years ago are inadequate to take care of the traffic of today. A recent study on the state highways of California made by the U. S. Bureau of Public Roads, discloses the average week-day traffic units to be divided in the ration of 97.3% motor driven and 2.7 horse-drawn. A real service is being done in directing public attention, not to the component parts of highway transportation, but rather to the product itself. A comparative statement covering he 11-year period, 1910 to 1921, is indicative of the relative development of these component parts:

	1910	*1921
Automobiles	487,000	8,404,000
Trucks	14,000	1,346,000
Totals	501,000	9,750,000
Maintenance Fund	$25,000,000	$180,000,000
Construction Fund	95,000,000	420,000,000
Totals	$120,000,000	$600,000,000

* Estimated.

This information is interesting and of value, as what is true in California is true of every other State in the country. Highway design must necessarily be based upon traffic, and the behavior of the various details of design observed under different ranges and types of traffic. Highway transportation is in a condition of flux. An immense growth may be anticipated in the next decade. Our rapidly growing mileage of completed highways, with the prospect of continuous increase each year of construction programs emphasize the urgent need of road information upon which to base sound, economical road building policies, that we may avoid the mistakes and disasters of unwise financial methods and unsound construction policies. The solution of engineering problems of design, maintenance and the like, depends largely upon the character of the traffic, its speed, and the unit loads the highway must carry. The true purpose of an improved highway is a high degree of transportation service at the least possible cost to the public and road user. Clearly a traffic census is not a panacea, but I insist that without a knowledge of the actual traffic, speed, type and weight, of a given area, we are working in the dark. The cities, states and nation have lagged and are way behind in road building while traffic has gone ahead at a tremendous pace. John N. Cole, State Commissioner of Public Works, said it would cost the State of Massachusetts $70,000,000 to widen the roads already built to a safe width.

A very important part of road construction is the sub-grade, as much depends on it. Without a good sub-grade you are sure to have faulty paving, for a machine or a pavement is only as good as its weakest part.

Much is being said about permanent paving, but I have never seen any paving of this kind yet; but there is such a thing as a permanent sub-grade and drainage, and with these two factors permanent it will be easy to build a nearly permanent paving.

Asphalt Pavements

Much can be said in favor of asphalt paving, for many of our trunk lines that take the heaviest traffic are of this type and have been down for a number of years and show no apparent wear. They are built with both the penetration and mixed methods, but I prefer the mixed method. The same care should be taken in this type of paving as in the other two kinds mentioned. In the laying of this paving I would recommend a 6-in. bituminous base, with a 2-in .or 3-in. asphalt top. This makes a resilient pavement that has been able to withstand the heavy blow and load strain of the heavy truck to a marked degree and is well up in the front rank of paving, but this is no new thing in paving, as it was known and used many years before the Christian era. No doubt there have been many changes in the methods of using and applying asphalts, since the early days. It is certain that the mode of transportation has changed most wonderfully.

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ASPHALTIC PAVEMENT CONSTRUCTION IN PROVIDENCE, RHODE ISLAND

New paving constructed by the Department of Public Works of the City of Providence, R. I., during 1921 included 22,584 sq. yds. of sheet asphalt which was laid on both cement concrete and asphalt macadam foundations, and 217,436 sq. yds. of asphalt penetration macadam pavement.

In the sheet asphalt construction a 6-in. cement concrete foundation was employed on the section between the car tracks and in all inaccessible areas which is was believed would not be subjected to very heavy traffic. A 6-in. asphalt macadam base was utilized under that part of the sheet asphalt which was laid between the car tracks and the curb, and on straight stretches where is was anticipated the brunt of traffic would be concentrated. The asphalt macadam foundation consisted of 2-in. trap rock, thoroughly compacted. Texaco Asphalt Cement was applied by four auto-truck distributors owned by the City, and was spread at the rate of approximately 1¾ gals. per square yard.

The large yardage of asphalt penetration macadam was laid on the residential streets of the City of Providence, and is now subjected to a variety of traffic. The work has been so satisfactory that it is planned to lay a still greater yardage during 1922. Texaco No. 96 Paving Cement was the asphalt used.

Contracts Awarded

ROADS AND STREETS

Ariz., Prescott—Warren Bros., Phoenix, awarded contract for impvt. of streets in business section here, at $198,522; Phoenix-Tempe Stone Co., awarded contract for conc. paving on S. Pleasant Ave., at $34,996.

Ark., Pine Bluff—Keliher Constr. Co., Little Rock, Ark., awarded contract for paving 36 blocks

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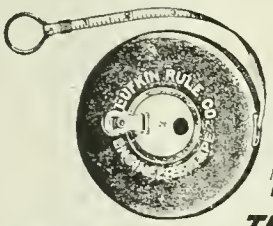

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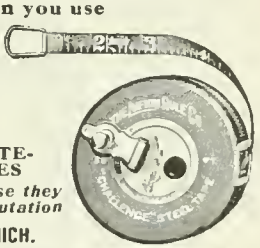

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in Linden St. Paving Dist. No. 52; 6-in. rein. conc. with curbs, gutters and storm sewers, 22½ and 30 ft. wide, at $94,387.

Cal., Fairfield—United Construction Co., Vallejo, awarded contract for 6 miles of highway work in Suisun Valley at $127,365. Work will start in spring.

Cal., Droville—Chico Contracting Co., awarded contract to build Chico-Butte City road; Clark & Henery, Stockton, contract for Oroville-Marysville and Gridley-Lane roads, at $1,800,000 total cost for above named roads.

Cal., Sacramento—F. Rolandi, San Francisco, awarded contract by State Hwy. Comn., for impvt. of section of Yosemite National park lateral from end of present 7-mi. contr. on park side of Mariposa to Briceburg station on Yosemite Valley R. R. and Merced River. Plans call for approx. 6 miles grading, 21 ft. wide. Cost of contract, $177,000.

Cal., Sacramento—Rhodes & Price, Hilts, Cal., awarded contr. for constr. of state hwy. in Santa Clara Co. betw. San Felipe and easterly boundary —about 16.8 miles to be graded, at $195,890; Conners & Hanson, Santa Rosa, awarded contract for constructing state hwy. in Mendocino Co. betw. Forsyth Crk. and Outlet Crk. about 17.3 mi. in length, to be paved with asph. macadam, at $264,-994; J. A. Costello, Jr., San Francisco, awarded contract for constructing state hwy. in Monterey Co. betw. King City and Salinas River, abt. 1 mile in length; one-half mile to be paved with asph. conc. and ½-mile on Dalinas river bridge to be surfaced with asph. conc., at $22,600.

Cal., San Diego—Calif. Constr. Co., 58 Second St., San Francisco, awarded contract to pave portions of several streets in Ocean Beach, at $142,953.

Cal., Santa Cruz—W. A. Dontanville, Hollister awarded contract for constr. of unit 11, 3.9 miles at Chittenden end, in conc., at $81,926; Cowden & Broderick, San Francisco, awarded contract for unit 10, the Boulder Creek end, 3.56 mi., at $67,258.

Conn., Hartford—State Hwy. Dept. let contract for paving 44,000 ft. Dursam Rd. Guildford to F. Arrigoni & Bros., 605 Main St., Middletown, $145,-000; 17,800 ft. Westfield Rd., Granby, to L. Suzio Construction Co., State & Brooks Sts., Meriden, $65,000; 3,800 ft., Litchfield-Torrington Rd., Litchfield-Torrington, to Mascetti & Holley, 561 S. Main St., Torrington, $32,000; 15,050 ft. Litchfield Rd., Goshen, to Ossola & Besozzi, 164 Pythian Ave., Torrington, $42,000; 17,000 ft. Colchester-Norwich Rd., Lebanon, to A. Brazos & Sons, 66 Oak St., Middletown, $50,000; 12,500 ft. Waterbury-Torrington Rd., Thomaston, to C. Vacca, Terryville Rd., Bristol, $58,000; 9,275 ft. Grosvenordale-Mechanicsville cut-off, Thompson, to G. T. Seabury, Inc., 100 Summer St., Providence, R. I., $44,000; 5,000 ft. Quaker Farms Rd., Oxford, to J. E. McGann, Jr., 42 Church St., New Haven, 715,000; 8,400 ft. Sherman Rd., New Milford, to C. W. Blakeslee & Sons, Inc., 58 Waverly St., New Haven, $56,000.

Fla., Bradentown—Finley Method Co., Jacksonville, Fla., awarded contract for constructing about 50 miles of rds., Manatee-Oneco Rd. Dist., asph.; bridges and shell-rut constr.; formed Wyakka Rd. Dist.; constr. 45 mi. rd. from Manatee-Oneco Dist. to De Soto Co. line, at $351,158.

Ga., Atlanta—McDouglas Constr. Co., awarded contract to repave Marietta and Decatur Sts.—Jones Ave. to Yonge St.—1¼ miles, at approx. $200,000.

Ga., Fairburn—Davis Constr. Co., Macon, Ga., awarded contract for constructing 8 miles conc. road from College Pk. to Fairburn; 18 ft. wide, at $200,000.

Ill., Abingdon—Graham-King Constr. Co., 550 So. Cedar St., Galesburg, awarded contract for paving Main, Pearl, Meek and Martin Sts., brick on conc. conc. curbs and gutters, at $150,000.

Ia, Davenport—Geo. Sheldon Co., local, awarded contract for paving 16-mile stretch of road in Missouri, at $400,000.

Kans., Leavenworth—Jas. Stanton & Son., Leavenworth, awarded contr. to lay conc. slab on Section B, Proj. 52, of Fort-to-Fort Rd., Leavenworth Co., at $114,458.

Md., Baltimore—P. Flanigan & Co., 2600 Harford Rd., Baltimore, awarded contract on percentage basis for street paving; also Baltimore Asphalt Blk. & Tile Co., 1320 N. Monroe St., and American Paving & Contracting Co., Montebello, at total cost of about $200,000.

Mich., Bessemer—W. S. Peters, Wakefield, awarded contract for improving 9 miles road in Wakefield Twp., at $112,755.

Minn., Little Falls—Following contracts let for St. Road Projects: 27-22, FAP 254, 10 miles and St. Proj. 27-01, FAP 264, 5 miles: Paving to McCree, Moos Co., 711 Mer. Natl. Bk. Bldg., St. Paul, 165,000 sq. yds. conc., at $345,000; Grading, M. Barrett, St. Cloud, $11,220; Culverts to Russell Grader Co., 2005 University Ave., SE. Minneapolis; Installing culverts to A. B. Peterson, Little Falls, Total $350,030.

Minn., Minneapolis—General Constr. Co., 1228 Plymouth Bldg., Minneapolis, awarded contract for 8 miles paving bet. Robbinsdale and Hamel, at $353,313; bitulithic to be used.

Miss., Ashland—F. D. Harvey, Memphis, awarded contract for bldg. 30 miles government road no. and so. thru County, at $198,000.

Mo., Eminence—Cooper's Constr. Co., St. Louis, Mo., awarded contr. to construct 4.006 miles State Rd. from Winona eastward and westward; grading excavating, constructing draing. structs., etc., at $119,087.

Bids April 21, 1922.

STREET IMPROVEMENT

Winchester, Ky.

The Board of Commissioners of the City of Winchester, Ky., will on April 21, at 2:00 P. M., in its Chamber at the City Hall, received sealed bids for the improvement of about 30,000 sq. yards of streets, to be constructed of Asphalt, Vitrified Brick or Concrete, according to the plans and specifications therefor on file in the office of the City Clerk or City Engineer.

The Commissioners reserve the right to reject any and all bids.

N. A. POWELL,
Commissioner of Public Works.

Neb., No. Platte—Abel Constr. Co., Lincoln, awarded contract for paving 40 blocks of streets here at approx. $200,000.

N. J., Cape May—Sutton & Corson, Ocean City, awarded contract for paving State Hwy. Route 14, Sec. 5, Cape May Court House-Swainton, at $118,-776.

N. J., Hackensack—J. Kinzley, 65 Hudson St., awarded contract for paving 2 miles Sec. I-B, St. Hwy. Route 10, 91% engr.'s est., $94,875.

N. J., Mays Landing—C. H. Earle, 173 Main St., Hackensack, awarded contract for reconstructing 41,752 sq. yds. Smithville-Mullica River, (Sec. 9) Ocean Hwy., St. Hwy. Route 4, bitulithic, at $374,533.

N. J., Salem—Masterson Constr. Corp., 15 E. 40th St., New York, awarded contract for reconstruct-70,328 sq. yds. Route 6, Sec. 10, Quinton-Marlboro, gravel, at $79,793; J. T. Burke, 309 Park Ave., Plainfield, awarded contract for 29,847 sq. yds. Route 6, Sec. 11, at $111,833.

N. J., Woodbury—M. Staub, Swedesboro, awarded contract for reconstructing state hwy. route 6, sec. 6, Oldmans Crk. to Mullica Hill, rein. conc., at $203,660.

N. Y., Mayville—J. S. Hart, Westfield, awarded contract for 4.5 mi. road bet. So. Dayton and Smith Mills, at $119,348; T. Fitzgerald, 89 Glisan St., Fredonia, awarded contract for 1.94 mi. rd. in Cassadago, at $57,800—both concrete.

N. Y., Albany—State Hwy. Comn. let following contracts: Impvt. of 3.25 mi. Hwy. 1562, Albany Co., to L. Mayersohn, 6 Catalpa Dr., Albany, at $85,466; 0.73 mi. Hwy. 1608, Broome Co., to Stento & Serafini, 74 Court St., Binghamton, at $46,460; 5.73 mi. Hwy. 8087 Cayuga Co., to Pathfinder Constr. Co., Inc., Fulton, at $179,995; 7.9 mi. Hwys. 5669 and 8088, Clinton Co., to Smith Bros. Constr. Co., Cleveland Bldg., Watertown, at $240,655; 3.79 mi. Hwy. 8086, Erie Co., to Wieberg Bros., Forks, $117,824; 8.41 mi. Hwy. 8089, Genesee Co., to E. J. Bailey, Brocton, $268,677; 8.5 mi. Hwy. 8090, Herkimer Co., to P. Morford and C. J. Nitsch, Fultonville, $243,075; 1.06 mi. Hwy. 5667, Montgomery Co., to J. B. Fazio, 4 Leonard St., Oneida, $57,765; 2.25 mi. Hwy. 1607, Orleans Co., to Sweeney and Boland, Rochester, $43,244; 4.14 mi. Hwy. 1609, Schenectady Co., to J. J. Bellotte & Son Constr. Co., Troy, $129,674.

N. Y., Holley—Sweeney & Boland, Rochester, awarded contract to improve second section of Clarendon-Byron Rd. in Orleans Co., two and a fraction miles in length, at $43,243; Ernest J. Bailey, Brocton, awarded contr. to improve Batavia-Bergen Rd., Genesee Co., at $266,677.

N. C., Raleigh—Following contracts let for road construction: 2½-mile stretch from Asheville to Craggy mountain, hard surfaced, to C. W. Lacy, Wilmington, at $95,583; B. C. Stevens, Asheville, contr. for bldg. the structures, at $6,109; R. H. Wright & Son, Asheville, contract for constr. of 12 miles waterbound macadam from Sylva to So. Car. line, at $23,430; structs. on proj., to W. T. Moore Conc. Products Co., Andrews, at $37,710; 1½ mi. gravel rd., Caldwell Co., let to Caldwell Co. Comn., at $24,448; brdgs. to R. M. Thurston, Lynchburg, Va., at $22,620; 6 mi. Polk Co., Columbus to So. Car. line, hard surfaced, to Southern Paving Co., Chattanooga, Tenn., at $195,469; brdg. work to Henry Constr. Co., Greenville, at $19,897; O'Brien Constr. Co., Birmingham, awarded contract for 14 mi. waterbound macadam from Franklin to Georgia Line, Macon Co., at $111,135; brdg. work to Griffith Constr. Co., Salisbury, Md., at $33,113.

N. C., Shelby—Asheville Paving Co. awarded contract for approx. 8 mi. Topeka asph. street paving, at $248,860.

Ore., Salem—E. A. Webster & Co., awarded contr. of Hood River Booth hill sect. of Mt. Hood Loop Hwy., at $114,392. Job includes 6.1 miles grading; Johnson Contracting Co. awarded contract for grading 12.1 mi. Mt. Hood Loop Hwy. known as Booth Hill-Forest boundary sect., at $74,121.

Ore., Salem—Following contracts, aggregating $400,000, let by St. Hwy. Comn.: Porter & Conley, grading 4.85 mi. and rock surfacing 24.09 mi. Nelson-Malheur Co. line sec. Old Ore. Trail, at $108,892; Solheim & Gustafson, paving Youngs Bay-Skipanon sec., Roosevelt Hwy. unit, 10.33 mi. conc. at $9,788; unit 2, 4.20 mi. bitum. to J. H. Tillman, $100,775; Solheim & Gustafson, grading and rocking .9 mi. thru Rainier, at $18,006; Marsh & Bauers, rock surfacing 15.54 mi. Weiser-Baker Co. line section Old Oregon Trail, at $68,100; Porter & Conley, rock surfacing 18.77 mi., Kamela-Ora Dell sec. Old Oregon Trail, at $79,685; Union County brdg. across Grande Ronde river and one over Dry Creek on La Grande-Joseph Hwy. to Union Brdg. Co., at $30,747.

Pa., Harrisburg—Following contracts let by State Hwy. Comn.: Clearfield Co., Pike 8217 ft., Burnside Constr. Co., Cresson, at $81,392; Knox, 16,812 ft. Burd Constr. Co., Cresson, at $146,054; Osceola Mills, 2,432 ft. Gifford & Pritchard, Philipsburg, $27,304; Sandy, 6,954 ft. W. C. Guncheon, Smethport, $52,122; Bradford Co.—Canton & Lorory, 34,432 ft. to A. W. Hinaman, Akron, O., $23,923; Athens Twp., 10,500 ft. Horn & Devling, Galeton, $80,329; Smithfield & Ulster, 37,712 ft. Horn & Devling, $291,758.

Pa., Phila.—M. J. McCrudden, Real Est. Trust Bldg., awarded contr. for paving Kensington Ave., from Ontario to Frankford Aves.; granite block, at $84,786.

Pa., Port Allegany—Clark Bros. Constr. Co., Hastings, Pa., awarded contract for road constr. in Blair, and Center Cos., at $371,367; Kavanaugh-Deniro Constr. Co., Youngstown, O., contract for road wk. in Clarion Co., at $211,049.

Pa., Pottsville—American Paving Co., Chester, will likely be awarded contract for street paving here at $183,000. Recent resolution rescinding contract will be reconsidered and contractors given mandate to go ahead with the work immediately. Asphalt adopted as material.

Tenn., Athens—Coker, Gamble & Brown, Chattanooga, Tenn., awarded contract to pave streets at $80,000.

Tenn., Memphis—Bryant Paving Co., Waterloo, Ia., awarded contr. by Bd. Commrs. for 28,700 sq. yds. sheet asph. and necessary draing. and grading, at $150,000.

Tex., Coleman—Burke & Hart, awarded contract for grading and surfacing; McCall-Moore Engrg. Co. the contr. for draing. work on 23 miles of rd. leading from Coleman to the Callahan Co. line near Cross Plains, at $250,000; Burke & Hart also awarded contr. for Brady road—5.14—100 mi. to Precinct No. 1 line, at $25,250.

Tex., Dallas—City let contr. to Texas Bitulithic Co. at $137,013 for paving S. Lamar St., at $137,013.

Tex., Dallas—Rawhide Paving Co., awarded contract for paving 30 miles Dallas Co. Belt Line road, at $8,000 per mile.

Tex., Livingston—Tibbets Constr. Co., Mineral Wells, Tex., awarded contract for constructing 10.31 miles St. Hwy. No. 35; gravel; $250,000 available.

Tex., Marlin—Hess & Skinner, Dallas, awarded contract for constr. of 26 miles road in Falls Co., Precinct 5, at $126,884.

Wis., Fond du Lac—Frank Doherty Co., Milwaukee, awarded contr. for Brandon-Ladoga job which calls for 16-ft. conc. hwy. 6.11 miles to Ladoga, at $112,154; Lampert Constr. Co., Oshkosh, contr. for Ripon-Rosedale Rd., 18-ft. conc. rd. from 3 miles east of here and extending 5.94 mi. along S. T. H. 23 to Rosendale, at $128,047; Froeming Bros., Inc., Milwaukee, awarded contr. for Fond du Lac-Eden job, 18-ft, hwy. 7.04 miles in length, at $141,127; Widell Constr. Co., Mankato, contr. for Waupun rd. job, 18-ft. conc. hwy., 12.42 miles southwest along S. T. H. N. 31 to city limits of Waupun, at $259,270; Brogan & Schaefer Co., Green Bay, contr. for Kewaskum-Waucousta proj., at $114,824—18-ft. hwy. 4.88 miles.

Wis., Marshfield—Wausau Iron Works, awarded contract for Senaca-Corners job, which includes link of Senaca with conc. toward Arpin on 13, and 3 miles west of Senaca on Wiscons Rapids-Bettsville rd., a total of $172,049, exclusive of cement which is to be furnished by the county; Larson Constr. Co., Eau Claire, awarded contract for constr. of Blenker-Milladore rd., at $1.93 per yd.

Wis., Racine—Brennan & Bounsall, Kenosha, awarded contract for Racine-Thompsonville rd., at $128,046.

Wis., Waukesha—Morris Martin, Berlin, awarded contract for impvt. of Templeton-Merton Rd., at $76,548; Waukesha-Wales Rd. to J. R. Griffith, Racine, at $148,291.

Wis., Waupaca—Joe McCarthy, Kaukauna, awarded contract for constr. of Clintonville-New London Rd., FAP 138, at total of $100,497.

Wis., West Bend—Geo. M. Gross, Appleton, awarded contract for FAP 304, at $163,543.

SEWERAGE AND SEWAGE TREATMENT

Ark., Pine Bluff—Geliher Constr. Co., Little Rock, Ark., awarded contract for storm sewer and paving in Linden St. Dist. 52, at $94,387.

Cal., Banning—R. E. Garretson & Co., 1346 Fairfax Ave., Los Angeles, awarded contract for storm sewers in Gilman & Indian Canyons, at $31,856.

Cal., Santa Monica—Joe Chutuk, 425 Bullard Bldg., Los Angeles, awarded contract for impvt. of Penn. Ave.—14th to 20th Sts.—at $65,048.

Cal., Watts—B. D. Baucus, 173 W. 43rd St., Los Angeles, awarded contract at about $484,000 for constr. of sewer system, including treatment plant for city.

Ill., Granite City—R. B. Higgins Constr. Co., St. Louis, award contract for completion of the outlet sewer at $300,000.

Ill., Winnetka—Gaedke & Donovan, Waukegan, awarded contract for san. sewers and water system, at $75,000.

Ia., Clarksville—Following contracts let for sewer system here: sewer pipe to Kruse Constr. Co., $33,518; disposal plant to H. E. Wilcox, $5,137.

Ia., Davenport—Matthes Coal & Constr. Co., Davenport, awarded contract for san. sewer in Duck Creek Dist. No. 11; 316′ 24 to 42″, 1 pumping sta., at $163,000.

Mass., Boston—S. J. Tomasello awarded contract for sewerage works in Sever St.—Haverhill to Kingston St., Charlestown, at 0898; C. & R. Constr. Co. contract for bldg. Dorchester brook sewer in Norfolk Ave., from about 240 ft. northwest of Franklin Court to E. Cottage Dorchester, at $32,522.

Mich., Detroit—For: (1) Woodward Ave. Arm of 7-Mile Rd. Sewer (2) Dequindre Ave. Arm of 7-Mile; (3) Coon Ave. Arm west of Wyoming Ave. sewer; (4) Joann Rd. arm of Gratiot Ave. sewer; (5) Buena Vista Arm of Wyoming Ave. sewer; (6) Fenelon Ave. arm of Lynch Rd. sewer; (7) Livernois Ave. arm of 7-Mile, to C. R. Lennane & Co., 2631 Woodward Ave., (1) $31,614; W. Blanck & Co., 827 Ford Bldg.; (2) $104,431; (3) $26,973; (4) $48,876; (6) $30,682; G. R. Cooke, 1260 Penobscot Bldg.; (5) $23,086; C. M. Davis Co., 400 Penobscot Bldg.; (7) $72,782.

Mich., Northville—Sgullo Constr. Co., Akron, O., awarded contract for 25,800 ft. 8 to 18 in. main san. sewer, Sec. 1 and 24, 300 ft. 8 to 12 in. Sec.

2, at $34,415 and $26,005 respectively; sewage treatment works, Imhoff tank, etc., to Denton & Johnson, Saginaw, at $34,750.

Minn., New Ulm—Rahr & Pratt, Pipestone, awarded contract for storm and san. sewers at $28,569; water impvts. to Feyen Constr. Co., 277 Burgess St., St. Paul, at $5,818.

Mo., Springfield—R. McSweeney, Springfield, awarded contract for storm sewers at $300,000.

N. Y., Brooklyn—A. M. Hazell, Inc., 26 Cortlandt St., New York, award. contract for remodeling sewer outfalls, Sec. 2-B, Biological Plant, 26th Ward Disp. Wks., at $96,121.

N. Y., Rochester—J. Petrossi Co., 201 Elwood Bldg., awarded contr., for 8,000 ft. 6-7 ft. conc. invert relief tunnel from Railroad to Main Sts., Main to Goodman Sts., Goodman to Webster Sts., and Webster to Bay Sts., with 800 ft. segmental blk., at $250,956.

O., Canton—Garaux Bros., 735 Market St., S. awarded contract for san. sewer in 12 blks. Wertz Ave.,—Tuscarawas St. W. to 12th St. N. W., etc., at $30,000.

O., Lakewood—Jos. & Kalill, 502 Huron Sq. Bldg., Cleveland, award. contract for sewer and water mains in Berea Rd., at $52,249.

O., Zanesville—E. & W. McShaffery, Akron, O., awarded contract for miles vit. pipe sewer here in Southwestern Sewer Dist., at $66,520.

Ore., Portland—J. F. Shea, awarded contract to build Oregonian Ave. sewer, at $51,668.

Wyo., Casper—Gordon Constr. Co. awardede contract for constr. of san. sewer in Dist. 10, at $7,722.60 if paid in cash and $43,678 if paid in bonds.

WATER SUPPLY AND PURIFICATION

Ark., De Queens—Campbell & Hengst, Dallas, awarded contract to construct water works, at $56,000.

Ia., Manning—W. B. Carter, 606 United Bank Bldg., Sioux City, and Bessemer Gas. Eng. Co., Omaha, Neb., awarded contract for pump house, 2 engines, 2 pumps, 1 well and 1 oil tank, at $17,995.

Mo., Graham—Pittsburgh-Des Moines Steel Co., Tuttle & Southwest 10th Sts., Des Moines, Ia., awarded contract for 4-6 in. mains, at $25,000.

N. Y., Brooklyn—Knight & De Micco, 448 E. Tremont Ave., New York, awarded contract for mains and appurts. in Shore Blvd., Ocean Ave., Manhattan Beach, Highland, Laurel, Poplar, Manhattan, Mermaid, Seagate and Surf Aves., Beach 38th and Beach 40th Sts., at $41,004.

N. Y., Long Island—Dominick Constr. Co., 246 Bowery, New York, awarded contract for mains and appurts. in Van Alst, East and Nott Aves., 1st Ward here, at $71,925.

N. Y., Newburg—Mapes & Erway, Warren, O., awarded contract for mech. filter plant, consisting of piping, drains, equipt. connections and appurts. of head house and filter house, etc., at $192,833.

N. Y., New York—Caldwell-Wilcox & Co., Newburgh, awarded contr. for furnishing and delivering gate valves, steel castings and appurts., for steel pipes of Catskill Aqueduct, f. o. b. at designated localities in Ulster, Orange, Putnam and Westchester Cos., at $36,170.

N. Y., St. George, S. I.—J. McAvoy, Jr., 313 E. 127th St., New York, awarded contract for hauling and laying mains and appurts. in Arthur Hill Rd. here, at $51,834.

N. C., Ayden—Robt. G. Lassiter & Co., Norfolk, Va., awarded contr. to extend water and sewer systems at $195,000; also pave streets.

N. C., Littleton—Bacon & Moore, Norfolk, Va., awarded contract to construct water, sewerage and electric light systems, at $96,000.

N. C., Winston-Salem—Porter Plumbing Co. awarded contract by Pillot Real Estate Company for constr. of 1½ miles water and sewer systems in Buena Vista Annex, at $18,000.

N. D., Fargo—Will remodel, repair and build addn. to filtration plant by Day Labor at cost of about $40,000. R. T. Johnson, City Engineer.

O., Delaware—Burgess & Niple, 141 E. Broad St., Columbus, awarded contract for bldg. and equipping softening and filtration plant, at $72,000.

Okla., Hobart—Ajax Constr. Co., Okla. City, awarded contract for constr. of water system and making certain addns. to sewer system, at $106,567.

Tex., Groesbeck—James Contg. Co., Southland Hotel, Dallas, awarded contract for water and sewerage systems, at $92,000.

Tex., Munday—Jones Construction Co., Dallas, Tex., awarded contract to construct water works, at $44,000; install 55,000 gal. tank elevated 100 ft. with 6 and 8-in. mains.

Wn., Puyallup—Troutman & Co., Seattle, awarded contract for replacing old wooden mains with cast iron pipe, at $15,690.

Wis., Milwaukee—J. B. Forrestall Co., 215 15th St., awarded contr. for mains in various streets, at $46,622.

Wyo., Greybull—Johnson & Cotner, Worland, awarded contr. for 200,000 gal. steel tank. 28, 30 ft. 2-8 in. mains, hydrants, valves, fittings, etc., at $50,609.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—City Comn. will expend $123,425 to improve sts.; pave 2nd Ave. thru to Tuscaloosa, at cost of $73,575; 24th St.—7th Ave. to 24th Sts., railroad crossing, asph. over 5-in. conc. base, $5,275; 8th Ave.—4th St. to west line Owenton surway; sheet asph. with 50-ft. rdwy extending over conc. base at $44,575.

Ala., Birmingham—City and Jefferson Co. will construct connect'g. roads within city limits, including Pratt City-Birmingham Rd., So. Bessemer connection, Fairfield-Fairview road, Mt. Pinson road and Woodlawn-Gate City road; 20-ft. hwy. of perm. paving; County will pay $325,000 and city $175,000. A. J. Hawkins, Chf. Engr. Claude A. Rogers, Co. Engr. Jefferson Co. Bd. of Revenue will also construct Ensley-Mulga-Edgeward-Wylam loop with extension to Parkstown 12 mi.; bitum. top on reconstructed base, $275,000; Warrior-Robbins Cross roads, 10 miles; chert, $75,000; Elbow to Port of Birmingham, 12 mi.; chert, cost $60,000; Trussville road to county line; chert; $50,000; grade Overton loop to Mims by filter plant, 5 miles, cost $40,000; Bradford-Trafford roads, 6 miles, graded highway, $50,000—total cost $550,000. Will ask bids. Claude Rogers, Co. Engr.

Ark., Eldorado—City has formed 8 Impvt. Dists. Plans to pave 43,000 ft. hard surface pavement.

Conn., Milford—Plans paving E. Broadway, Ft. Trumbull Beach, $86,000; North St., $16,700; Broad St., $10,000; Hillside Ave., $14,500; Gulf St., $15,000; Daniel St., $3,800; West River St., $10,000.

D. C., Washington—Dist. Commrs. will improve Ninth St., Dupont Circle, P and R Sts. at cost of $60,700.

Fla., Ft. Lauderdale—Broward Co. will construct roads, including widening and rebldg. Dixie Hwy. 26 miles. $600,000 available. F. A. Bryan, Clk. Co. Commrs. H. C. Davis, Engr.

Fla., Jacksonville—City Comn. authorized advertisement for bids for impvt. of 5 streets; brick on conc. on Adams St.; brick on sand on First St.—Evergreen to Florida Ave.; and asph. on conc. on portions of Margaret St. Hogan and King Sts.

Ga., Atlanta—Fitzhugh Knox Real Est. Co. will construct streets in 65-acre site to be developed.

Ga., Oakland—Realty Sales Corporation will grade and pave streets in 100-acre site to be developed.

Ga., Rome—Floyd Co. and State Hwy. Comn., Atlanta, Ga., will construct 5½ miles Summerville Rd from Armuchee to Chattanooga Co. line. For detailed information address Bd. of Rds. & Revenues, Rome or State Hwy. Comn, Atlanta.

Ill., St. Charles—Council passed Ord. for paving Geneva Rd. As soon as court proceedings are finished bids will be advertised.

Ky., Williamstown—Grant Co. voted $250,000 bonds for completing concrete highway extending from Covington to Scott Co. line.

La., Donaldsville—Ascension Parish will construct roads in Third Road Dist., New River Section. Voted $100,000 roads.

Minn., Elbow Lake—Bids will soon be asked for graveling state road 3; 5 miles. Survey will be made of Elk Lake St. Rd. from Barrett E. to co. line. State Rd. 8 will be graveled. W. E. Burgess, Co. Hwy. Engr. C. M. Nelson, Aud. Grant Co.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Mo., Chillicothe—City Council has approved City Engr's. plans for resurfacing with Tarvia portions of Webster, Vine, Monroe and 2 blks. on Irving Ave.

N. Y., Albion—Orleans Co. soon to advertise for bids for paving 2.36 miles Albion-Eagle Harbor Rd., $30,000; 2.6 mi. Knowlesville-Ridge Rd., $38,000—both concrete. H. D. Waldo, Co. Supt.

N. Y., Dansville—$60,000 bonds voted to pave Lackawanna Hill Rd. J. Stiegler, Pres.

N. Y., Ellicottville—Will soon take bids for completing roads now under constr. and new 4 mile road bet. here and Ashford, $60,000.

N. Y., Geneva—Bd. of Public Works soon opens bids for paving Pultney, Grove and High Sts., Nursery and Lafayette Aves.; asph., $145,256; conc., $149,083; brick and conc. $181,019.

N. Y., Holley—Orleans County considering paving 2.5 miles Kendall-Morton Rd., 16 ft. concrete. Est. cost $36,000.

N. Y., LaSalle—May pave River Road. Est. cost $45,000.

N. Y., Medina—$38,000 bonds voted to pave West Ave. C. H. Pettis, Pres.

N. Y., Warsaw—Board of Supervisors, Wyoming Co., has approved plans, specfs. and estimates of cost of Wyoming Village-Ridges Corners improved highway and has appropriated the $22,000 which is county's share of cost of impvt. Est. cost of highway is $65,000. Distance is .89 mile; is to be conc. street 18 ft. wide, and portion within built up section of village is to be widened to 30 ft. with curbing, etc.

N. D., Carrington—Following road work considered. E. road to 10 miles east of city to be graveled. F. A. Road to be established from Melville to Carrington. E. K. Scheaefer, Co. Aud. Foster Co.

Ore., Portland—$11,000,000 will be expended by State Hwy. Comn. on road work. Program calls for completion of nine important thoroughfares. 6 million are for work to be let, $5,000,000 for work under contract or commitment; 6 million includes $1,500,000 due from counties and $2,000,000 from government. The $2,500,000, set aside for Roosevelt Hgy. calls for co-operation with Fed. Gvt.

Tenn., Dyersburg—Ords. passed for paving three streets with asphalt.

Tenn., Knoxville—City may advertise for bids in near future for paving portions of about 9 streets.

Tex., Georgetown—$100,000 bonds voted for street paving and fire equipment.

Tex., Beaumont—Jefferson Co. Commrs. Court will construct 45 mi. conc. road and 90 miles shell roads; build bridge; cost $2,000,000. A. C. Love, Co. Engr.

Tex., Tyler City—H. J. Graeser, in charge, will construct ½-mile paving; 8-in. rock base or bitum. top. $20,000. Constr. by city forces.

W. Va., Wheeling—30 miles of country roads will be rebuilt by County this spring because of road constr. undertaken by state on National pike. Co. Engr. Alex. Hoffman has made estimates of various projects.

Wn., Aberdeen—Petitions filed for grading and graveling W. 7th St. impvt. of Fairview Blvd. and 25 blks. in circumscribed area in Broadway Hill district. East Second street will be improved. Several other streets in South Aberdeen may be filled and improved.

Wash., Yakima—C. H. Cecil, dist. forester, announces that Stevens Pass will be improved this yr. from east portion of Cascade tunnel to Merrit, 17 miles; Kittitas Co. sect. of Blewett Pass road will be finished; 11 miles Blewett Pass rd. in Kittitas Co. will be finished at cost of $150,000 to $200,000. It will be graded and graveled. In addn., Chelan Co. will expentd $45,000 on northern end of Blewett Hwy.

Wis., Medford—Plans prep. for 16,000 sq. yds. conc. paving on Wisconsin Ave., Main, Whelan, State and Divisions Sts. S. P. Hall, Engr., Ingram Blk., Eau Clairs. H. Maurer, City Clk.

Wis., Wausau—Will pave 10,500 sq. yds. reinf. conc. integral curb on Clarke, Callon and W. Washington Sts. B. C. Gowen, City Hall, Engr., F. N. Blecka, City Clk.

SEWERAGE AND SEWAGE TREATMENT.

Cal., San Bernardino—City Engr. C. E. Johnson has issued petitions for approx. 2½ mi. sewer work covering northeost dist.

Ont., Eastview—City plans constr. of 3 miles sewers in Montreal Rd. and several streets at cost of $52,000. L. S. Abbott, 410 Weston Bldg., Engr.

Colo., Colo. Springs—City Council has requested City Atty. to draw up resolution creating storm sewer draing. dist. on west side. This is 1st step toward installation of storm sewer sys. which will cost prop. owners total of $74,000.

Ill., Dixon—Plans being prepared for 10-14 in. vitr. tile sewers here. $27,000 est. cost. D. N. Clayton, Engr. City Hall.

Ill., Waukegan—Sewage disposal plant costing upwards of $160,000 will be constructed here in near future, according to plans being made by North Shore San. Dist.

Mich., Detroit—City considering 1191 ft. Clark Ave. sewer, Sec. 1, in Summit Ave.—Jefferson Ave. thru Riverside Park to Harbor line, 7 ft. 6-in. x 8 ft. 8-in., 4 ft 6-in. cylinder connections, rein. conc. and brick; Martin Ave. sewer in Martin Ave.—Pittsburgh Ave. to 1247 ft. no., rein. conc. vit. segment blk. brick or monolithic conc., 4 ft. cylinder. C. W. Hubbell, City Engr.

Mich., Kalamazoo—Plans being prepared for sewer in Dunkley, Birdick, Millview, Stockholm, Fair, DeWitt and Eggleston Sts.; 10,000 ft. 18, 20, 24, 30 and 54 in. pipe, $140,000 bond issue approved. E. S. Clark, City Engr.

Minn., New Richland—Plans under way for san. sewerage system at cost of $30,000. L. P. Wolff, Engr., 1001 Guardian Life Bldg., St. Paul.

Mo., Joplin—Ords. passed by City Comn., establishing Shoal Creek sewer districts Nos. 3 and 4 and ordering constr. of public santitary sewers in the districts. Ests. on projects submitted by S. P. Ashcraft, City Engr. There are to be 1686 lin. ft. sewere pipe in sewer to be laid in alley bet. Main and Joplin Sts. and 1920 lin. ft. in

Mont., Glendive—City will construct storm sewers throughout City this Summer; also relay water mains, $50,000.

Neb., Grand Island—City Council has called election to vote on sewer bond issue in sum of $300,000—$200,000 being for sanitary sewerage and $100,000 for storm sewers.

Neb., Lyons—Plans under way for complete san. equipt. and sewer, $50,000. Frank Fulton & Letton, Engrs., 505 Bankers Life Bldg., Lincoln.

N. Y., Binghamton—Plans san. sewers in 12 streets and storm water sewers in 2 streets. Cost will exceed $25,000. W. E. Weller, City Engr.

N. C., Asheville—City planning installation of additional sewer and repair of old ones. Will issue $100,000 bonds. H. J. Sherrill, Commr. Pub. Wks.

N. C., Conover—City plans sewer and water works system at cost of about $50,000. Spoon & Lewis, Engrs., Greensboro, N. C.

N. C., Lumberton—Town Commrs. will extend sewer and water systems; will issue $120,000 bonds.

N. C., Mt. Airy—Town Commrs. plan to sell $75,000 bonds for instalaltion of sewerage system.

N. C., Roxboro—City contemplates installing sewer system at cost of $40,000. Spoon & Lewis, Engrs., Greens boro, N. C.

N. C., Winston-Salem—City plans expendt. of $200,000 to install sewer and water systems in Southside. H. L. Shaner, Commrs. Pub. Wks.

Ohio, Port Clinton—W. H. Ditto, Columbus, State Engr. met with Port Clinton Council to discuss sewer impvts. planned for City. Temp. impvt. is to eliminate depositing sewage in Lake Erie at Fulton and Depot Sts. and place temporary branch sewer along First St. to river.

Okla., Wilburton—$201,000 carried at election here. Funds will be spent for san. sewer system, impvt. of light plant and purchase of fire fighting equipt.

Tenn., Memphis—City will improve and extend sewer system; will issue $150,000 bonds.

Tenn., Ridgely—Town will construct sewerage sewerage and water systems, for which $60,000 bonds have been issued.

Tex., Port Arthur—City will extend sanitary and storm sewers; 6-in. to 36-in. vit. pipe and conc. pipe. Nagle, Witt & Rawlins, Cons. Engr.

Tex., Weatherford—$25,000 bonds sold for sewer extensions. G. Parker, City, Engr.

Va., Petersburg—City plans expending from $25,000 to $30,000 to construct 30-in. sewer. Louis Brownlow, City Mngr.

Wn., Tacoma—Plans comb. san. and storm trunk sewers (rein. conc.) in part of west end, south side, all of S. Tacoma and Manitou, 6 miles long. $1,000,000.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
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Paving Blocks (Creosoted).
The Barrett Co.
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Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

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Austin Machinery Corporation.
Cummer & Son Co., The F. D.
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Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Wis., Oshkosh—City plans 6-12 in. vitr. storm and san. sewers in various streets at cost of $35,000. G. W. Randall, City Engr.

WATER SUPPLY AND PURIFICATION.

Ala., Birmingham—Birmingham Water Works Co., plans increasing capital from $2,529,700 to $3,029,700 for plant impvts; erect plant additions; extend water supply pumping and purification equipt.; distribution system; services, meters, etc.

Ark., Fort Smith—City plans to improve water works; improve distribution system; construct additional mains and cross feed lines; 3,000,000-gal. reservoir on Crow's Hill, etc. E. Kiersted, Cons. Engr., Kans. City, Mo.

Ark., Springdale—City will improve works; lay 2 mile pipe to Stultz Spring; install elec. pumping station. Purchased additional site.

Cal., Moorpark—$25,000 bonds voted here for water system and Engrs. F. G. Dessery and E. R. Bowen, Central Bldg., Los Angeles, selected as Cons. Engrs.

Alta., Coleman—Constr. of water works system to serve West Coleman is being considered. By-law will be submitted.

Ont., Galt—Mgr. W. H. Fairchild, Pub. Utilities Comn., preparing report on proposition to lay water main across river to feed east side of city.

Ont., Long Branch—Petition signed by practically all residents will be presented to Etobicoke Twp. Council, urging creation of water area here and immediate installation of water system.

Ont., Niagara-on-the-Lake—Michigan Central Ry., 15th St., Detroit, Mich, having plans prepared for 4-in. mains and new standpipe here. Est. cost $35,000. A. Leslie, care Mich. Cent. St. Thomas, Engr.

Ont., Smith's Falls—Town Council served with writ at instance of Provincial Bd. of Health, for non-compliance with order for installation of filtr. plant.

Que., Quebec—Power given to Que. Streams Comn. to build gigantic dam on Quarea River, Laurentian Mountains, beyond St. Agathe, at cost of $250,000. Work will be started in Spring and will include erection of storage dams at Lakes Quarea, Archambault and Blanc.

Fla., Seabreeze—City wil install water works; $55,000 bonds voted.

Fla., Quincy—City considering constr. of hydro-electric plant to cost about $175,000. J. P. Smith, City Clk.

Ill., Hinsdale—Bids will be received about June for constr. of 6-8-in. cast iron mains. $25,000. E. Hancock, Engr., 2047 Ogden Ave., Chicago.

Ill., La Salle—Making plans for laying 4-6 in. cast iron mains. $25,000. E. Byrne, City Hall, Engr.

Ky., Newport—City will take bids within 90 days for new 6-million gal. pumping engine. Est. cost $150,000.

La., Houma—$200,000 bonds voted for water and purification plant and electric lights.

Mich., Port Huron—Plans prepared for new intake well, also 2 intake pipe lines 30 in. diam., extending 150 ft. into St. Clair River. $15,000. Work will probably be done by day labor under direction of D. D. Worcester, City Engr.

Minn., Sauk Centre—Plans under way for extension to water works. J. E. Cooper, Vil. Clk. Engrs. L. P. Wolff, Guardian Life Bldg., St. Paul.

Neb., Columbia—City contemplates installing new storage tank, 250,000 gals. H. R. Robertson, Mgr. Ltg. Co. interested.

Neb., Ogallala—Plans completed for constr. of large reservoir at head of S div. canal at Ovid, Colo., to carry water to reservoirs on table land in Keith and Perkins Cos. Hydro elec. power is contemplated. Keith, Deuel & Perkins Cos. Irrg. Assn. Jno. Schwin, Ogallala, Pres.

N. Y., Scottsville—Plans being made for water and sewage disposal system, including pumping station, standpip, filtr. plant, etc. $100,000.

N. C., Conver—City will construct water works system; install wells, pump, motor, tank, hydrants; about 2¾ miles 4-in., 6-in. and 8-in. cast iron mains; motor driven plunger pump 150 gal. per min., 160 ft. head; 75,000 gal. tank on 90-ft. tower, cost abt. $35,000. Spoon & Lewis, Cons. Engrs., Greensboro, N. C.

N. C., Lumberton—Town Commrs. will extend water and sewer systems; will issue $120,000 bonds.

Ohio, Cleveland—City considering cast iron main from Kirkland Pumping Sta. to new Baldwin Reservoir at cost of $1,700,000. A. V. Ruggles, City Hall, Engr.

Ohio, Germantown—City planning to lay 65,000 ft. 4-12 in. mains and construct deep well system. $100,000. Jennings-Lawrence Co., Hartman Bldg., Columbus, Engrs.

Ohio, Salem—City considering constr. of rein. conc. reservoir, tank house, pipe lines, etc. Est. cost $500,000. M. Knowles, Jones Law Bldg., Pittsburgh, Pa., Engr.

Ohio, Wellsville—Prelim. plans being made for 3½ miles of pipe lines, filtr. plant, 2,500,000-gal. capy., and new dam. $300,000. Morris Knowles, Inc., 1004 Hanna Bldg., Cleveland, Engrs.

Ore., Portland—Bd. Water Commrs., Corvallis, by E. L. Strange, Supt., has applied to State Engr., Percy A. Cupper, for permission to construct reservoir on Rock Creek, tributary to St. Mary's river, to store 535 acre ft. of water. This is part of proj. to enlarge present water system at cost of $100,000.

Okla., Apperson—It is planned to install electric pumps and construct water works.

S. C., Winston-Salem—$200,000 may be expended here for installing water and sewer systems in South side. H. L. Shaner, Commr. Public Works.

S. D., Rapid City—Prelim. plans made for impvt. of water works. Burns & McDonnell, 402 Inter State Bldg., Kansas City, Mo. Jno. J. Hays, Supt. of Water Works.

Tenn., Knoxville—N. E. Logan will install water mains in 175 acres of Kingston Pike Development.

Tenn., Memphis—Fuller & McClintock, Cons. Engrs., New York City, retained by City to prepare plans for artesion water works system. Est. cost $2,000,000.

Tex., Baird—$60,000 bonds voted for impvt. of water works, including conc. reservoir and enlargement of mains.

Tex., Cameron—Cameron Water, Power & Light Co. will improve plant; increase capy.; install additional treating plant at cost of $40,000.

Tex., Childress—City considering constr. of lake and reservoir; plans voting on $300,000 bonds. R. G. Carraway, Engrs.

Tex., Highland Park, (P. O. Dallas)—City will purchase and extend Highland Park water works. $150,000 bonds voted. H. R. Davis, Mayor.

Tex., Stephenville—$50,000 voted for water works impvts. here.

Va., Ashland—Town contemplates expendt. of $70,000 to extend water and sewer systems.

Va., Danville—Town Council considering issuance of bonds to improve streets and increase water supply. $20,000 wil be used to erect filter plant and bring additional supply of water from a mile or more beyond town.

Va., Harrisonburg—City will construct additional supply reservoir at cost of $40,000. Extend 20-in. pipe line from source of city's water supply 15 miles west of town to new reservoir at cost of $115,000.

Va., Pennington—Pennington Water Co., (Walter R. Pennington) plans expendt. of $40,000 to $46,000 on water works plant, install gravity flow line, daily capy. 300,000 gals. reservoir with capy. of 100,000 gals. E. E. Thompson, Engr.

W. Va., Grafton—Citizens in favor of bond issue for water works impvts. Pure Water League (composed of women) strongly in favor of purifying water supply.

W. Va., Rivesville—City plans expendt. of $40,000 to install water works; 40,000 gals. daily capy.; install centrif. pumps, omtors, etc., construct 50,000-gal. wood reservoir. B. Kress, Engr., Elkins, W. Co.

Wis., Milwaukee—City Engr. and Cons. Engr. of West Allis also Acting City Engr. of Milwaukee will determine location for a 24-in. main to increase water pressure in West Allis and whether standpipe or reservoir should be built in the suburb to increase the pressure in the higher districts. H. P. Bohmann, Supt. Milwaukee Water Dept.

Wis., Prairie du Sac—City will soon take bids on 100 water meters. J. B. Ragatz, Clk.

Wis., Tomahawk—Revising plans for reservoir. Owner—Wisc. Valley Impvt. Co., (Walter Alexander, 320 McIndoe St., Wausau). W. E. Brooks, Engr., 1st Natl. Bank Bldg., Wausau. Est. cost $100,000.

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Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil nnd Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barber Asphalt Co.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
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Wood Block (Creosoted).
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in Dallas, Texas, after four and one-half years' use.

"*Subject:* Rusurfacing Macadam Streets—
Warrenite-Bitulithic Pavement.

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Carrying the light, horse-drawn traffic of a few years ago was one thing. Carrying the swiftly moving automobiles and pounding motor trucks of today is quite another.

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Denver	Kansas City	New York	Salt Lake City	Washington, D. C.

Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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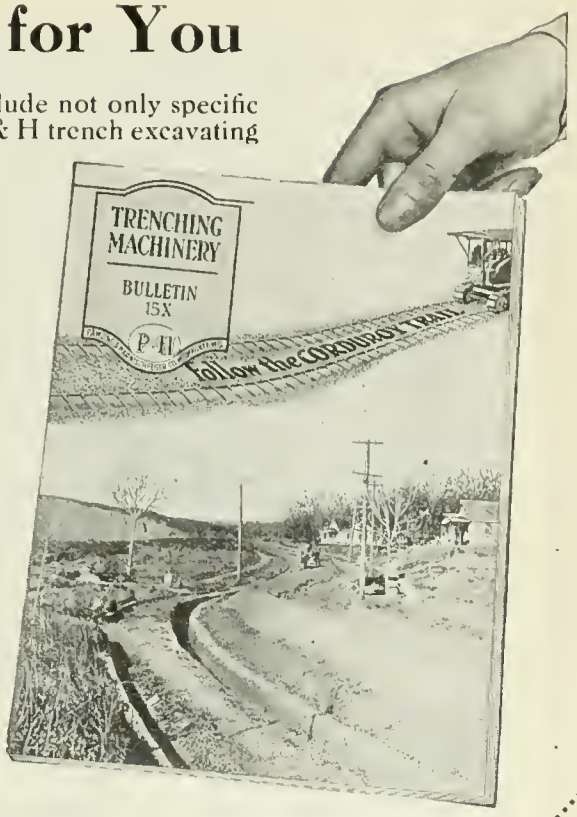

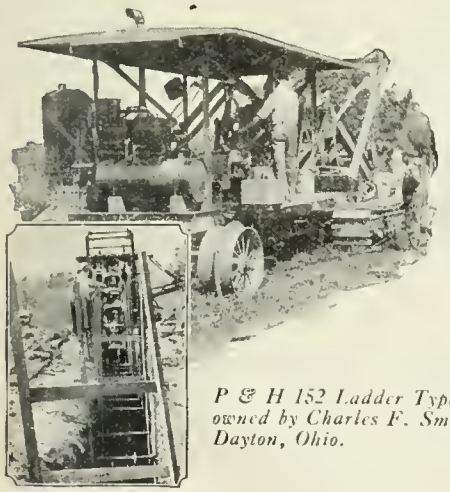

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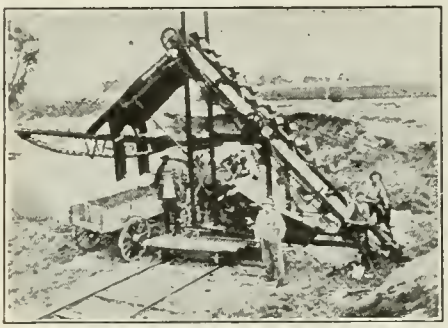

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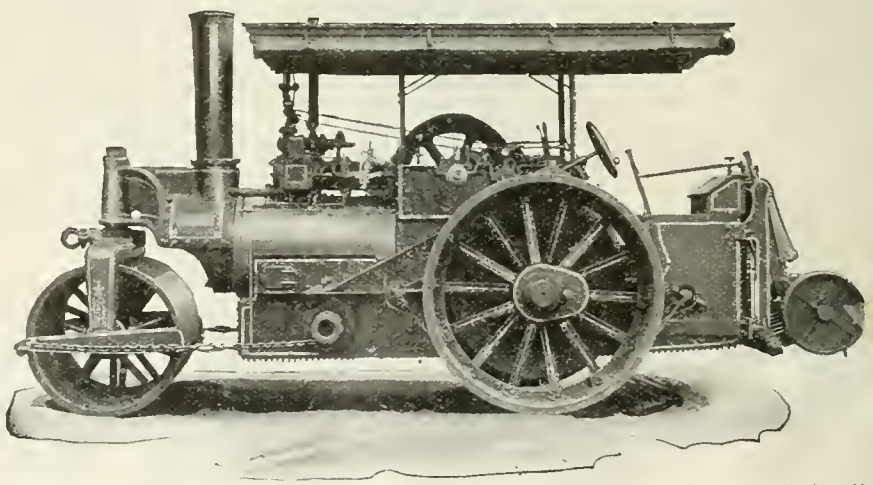

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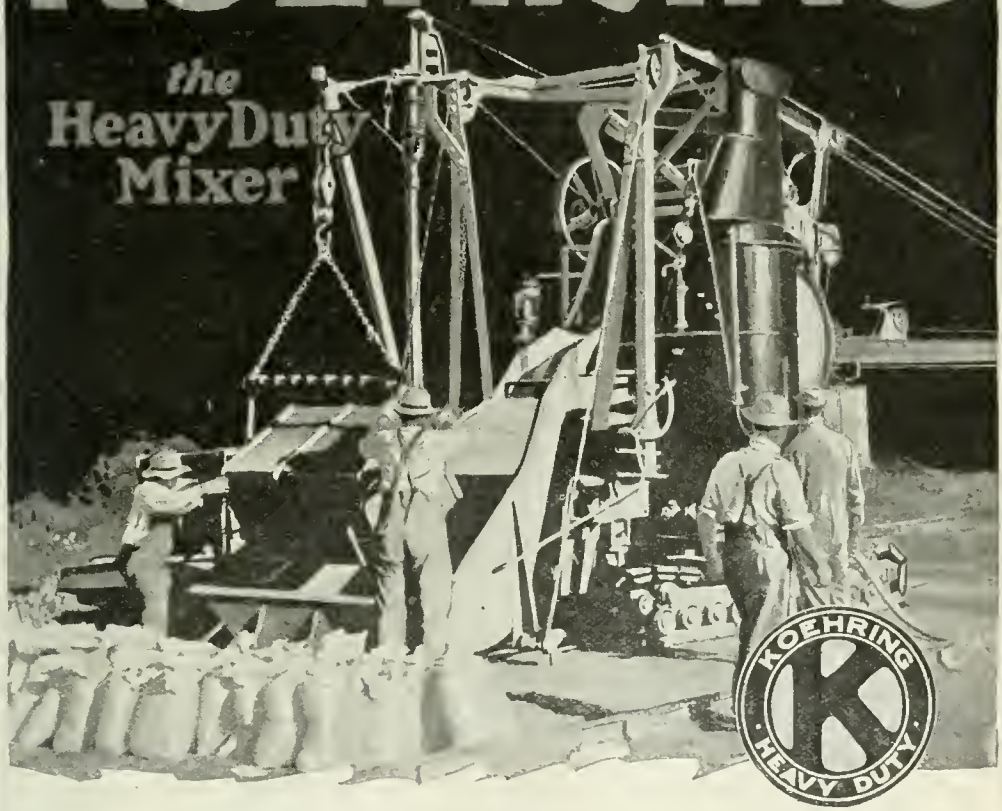

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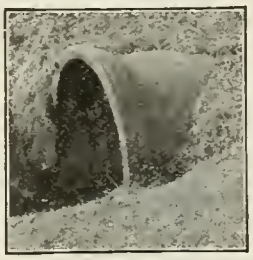

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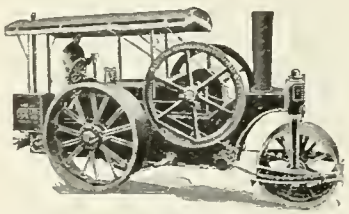

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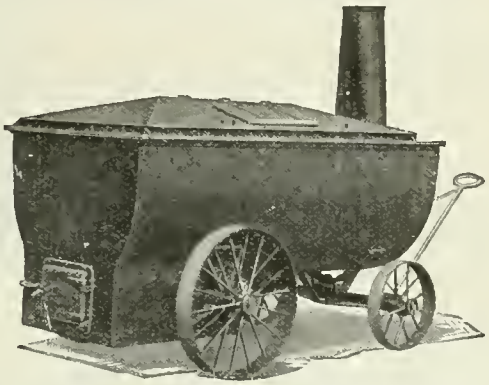

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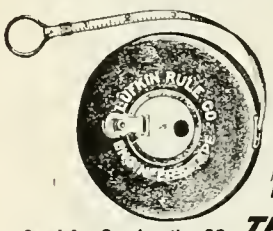

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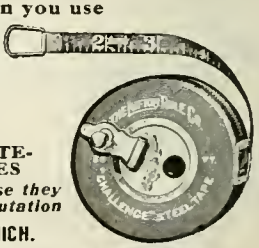

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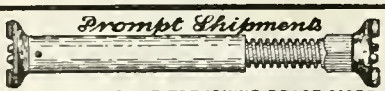

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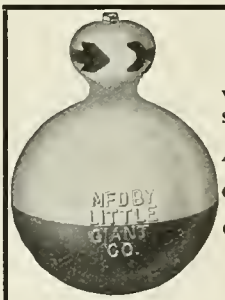

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Self-righting and non-destructible.

A street ornament—not an eye-sore.

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Saves 50% in Labor

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BURCH STONE SPREADER

You may save the cost in a mile on any road where slag, stone or gravel is laid. Then each mile thereafter will add to your profits, and you will do a better job in less time.

Write to us for proof and particulars.

THE BURCH PLOW WORKS CO.

144 Bucyrus St. CRESTLINE, OHIO

Motor Truck Operation and Accounting—81

MOTORIZATION OF REFUSE COLLECTION SERVICE IN LOS ANGELES, CALIF.

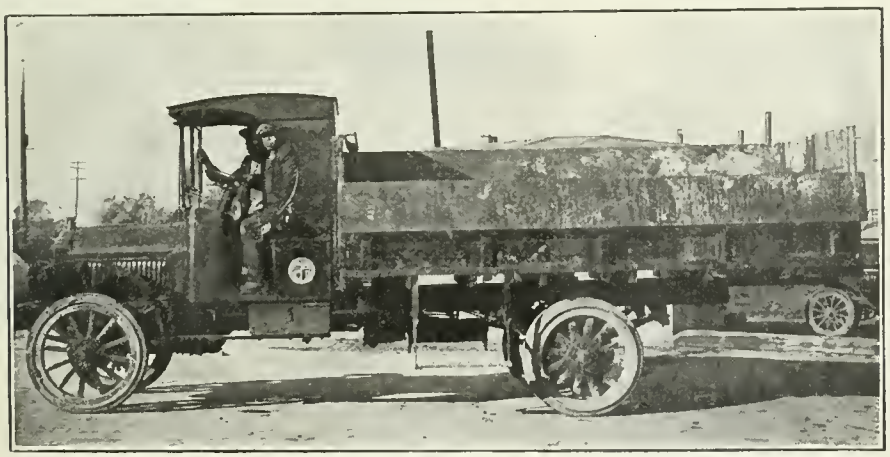
In the installation of 15 motor trucks of 2½ tons capacity for the hauling and removal of rubbish and garbage, City Engineer Griffin, Los Angeles, Calif., has estimated a saving of approximately $25,000 per year over and above the former private contract cost. Previous to the installation of motor equipment by the city, this work involved an expenditure of a sum almost equal to $70,000 per year. The trucks purchased for this work were Model 70-H Garfords, equipped with special bodies, as shown in the accompanying illustration.

The bodies, with a measurement capacity of 10 cu. yds., are arranged with hinged sides, which facilitates easy collection of load. With the sides dropped, approximately two-thirds of a load can be attained. The sides are then conveniently raised, after which the maximum capacity can be reached. Steps are provided on each side of the body for the lifting and dumping of rubbish cans over the highest point with the least possible effort. Quick discharge of the load is obtainable by means of releasing the tail gates hinged at the bottom at the rear of the body.

The Los Angeles authorities designate certain sections of the city in which the trucks will collect rubbish and garbage on given dates. Boxes containing tin cans and noncombustible rubbish are set near the curb by property owners. The trucks are manned with a driver and two helpers, who pick up boxes from the curb, dump the rubbish into the truck as it passes along. In sections of the city where long alleys run between the rear of houses, it is compulsory for the property owners or occupants to place the boxes on a shelf, which eliminates the necessity of helpers stepping down, thus saving time in loading. When the trucks are fully loaded, they are driven to a privately owner foundry, backed up to a dump and there unloaded. Through an incline of the dump, the tin cans and rubbish slide to an endless belt about 40 ft. in length, where broken glass and bottles are segregated, after which the tin and metal is elevated to a bin and pressed into a solid mass about 3 ft. square. These squares are later melted and made into window weights.

The garbage trucks operate in much the same manner as the rubbish collectors. Open sheet iron bodies are provided. When fully loaded they are driven to flat cars with steel sides, bodies with load elevated by means of a crane from chassis over flat car and dumped. This operation is made in not over five minutes' time. The loaded cars are then made up into "The Garbage Special" and taken to a ranch a few miles from the city.

This system of rubbish and garbage removal and disposal is making for better



GARFORD 2¼-TON TRUCK WITH SPECIAL MUNICIPAL REFUSE BODY. THE CITY OF LOS ANGELES OPERATES A FLEET OF 15 OF THESE UNITS.

and more satisfactory sanitary conditions in the City of Los Angeles.

A 30-MILE SPECIAL MOTOR TRUCK HIGHWAY PROPOSED IN CONNECTICUT

(Editor's Note: The following well-rounded statement pertaining to the proposed special 30-mile motor truck highway in Connecticut, published in The Hartford Courant of April 26, 1922, was brought to our attention by Mr. Charles J. Bennett, State Highway Commissioner, Hartford, Conn.)

Owners of motor trucks using the 30-mile state highway which it is proposed to build in Connecticut exclusively for motor trucks, would be required to furnish the $1,500,000 or more to pay for it, under a plan evolved by the state highway department for presentation to the Legislature.

By the assessment of a tax of 2 cts. a ton mile against each freight-carrying truck passing over the highway, the plan contemplates the raising of about $280,000 a year until the cost of the project has been liquidated. Whether the money would be collected in toll charges similar to the manner in which such charges are taken up on Connecticut toll bridges is a detail which is left for development pending the action of the Legislature and a determination of the constitutionality of the plan.

The department's figures are based on an exhaustive survey of truck and passenger traffic over the Boston Post Road at Greenwich and the state highway at Thompsonville, which showed that approximately 14,000,000 ton miles of pay freight each year pass over the highway route between Bridgeport and the New York state line which it is proposed to parallel with the truck highway.

$12,210,000 Transportation Value.

Freight, the transportation cost to the consumer of which is estimated at $2,210,000 a year, at prevailing railroad rates, is using that section of the Boston Post road today, according to figures drawn from the highway department survey. Figuring the value of the passenger service rendered by a million passenger cars using the section annually, at the railroad rate of 3.6 cts. a mile, the passenger service on that road for a year is estimated at $10,000,000. Taken together with the value of freight transportation, this makes a total of $12,210,000 in transportation value.

It is figured at the rate of 3.3 passengers for each automobile riding an average of 50 miles and an average truck haul of 47.4 miles. The value of freight transportation to the consumer is put between 12 to 18 cts. a ton mile.

Most Regular Trucking Companies

It was shown by the survey that 55.6 per cent. of the trucks passing through Greenwich are regularly engaged in hauling freight over that state road. About 16 per cent. are 2-ton trucks, 12.7 per cent. 5-ton trucks and 4.2 per cent. trucks over 5-ton capacity, which was taken to indicate that the heavy trucks, over 5 tons, do not constitute a serious factor in Connecticut traffic at this time. Every third truck was found to be overloaded, and the overloading was not by any means confined to loads of heavy material such as sand, gravel and brick. It is restricted to no typical group of commodities, but is almost universal. Of the number of loads exceeding the state limit of 25,000 lbs., 87.8 per cent. were overloads per capacity; 88.7 per cent. were by regular trucking companies. Thirty-nine out of 41 trucks were loaded from 846 to 1,560 lbs. an inch of tire width on the rear axle, the maximum allowed by statute being 800 lbs.

3,250,000 Passengers Carried

The highway department survey was made during two weeks last October in co-operation with the Bureau of Public Roads of the United States Department of Agriculture, but such a mass of information was collected that it was not until this week that the statistics of the survey were completed. The daily average of passenger cars passing the checking station at Greenwich proved to be 3,800 and, as it was shown that each car carried an average of 3.3 passengers, the conclusion is that over 3,250,000 passengers a year are carried over the road.

Over 53 per cent. of the passenger cars observed carried Connecticut license markers, 37.4 per cent. had New York markers, 3.2 per cent. Massachusetts and the same percentage New Jersey. The daily truck average was 792. The number of motorcycles and horse-drawn vehicles on the highway was so small in comparison with passenger cars and truck traffic that their numbers were not reported.

Recommends Separate Roads

It was pointed out at the highway department that the daily average of motor trucks on the Boston Post road is too great for the safety and comfort of people in passenger cars and that the num-

ber of the latter was so great as to handicap the rapid movement of commerce in the hundreds of trucks. These recommendations, based on an analysis of truck overloading, were made as a result of the census.

1. Classification of highways.
2. Seasonal restriction of loads.
3. Prohibition of overloads per capacity and restriction of tire to 800 lbs. an inch width of wheel.

Development of the first recommendation led to the proposal recently announced in "The Courant" for the construction of the 30-mile state highway for motor trucks only, extending from Bridgeport to the state line at Greenwich.

Might Take Twenty Years

It was said at the highway department that the constitutionality of taxing motor vehicles for the use of such a road was a matter that would have to be determined by competent authority and that the department was merely interested in suggesting a possible way for financing the project, which incidentally would be unique in road building in the United States. If the ultimate cost of the road should reach $2,500,000, for instance, it was felt that the cost, plus interest in the event of a loan, could be covered by the 2-cts.-a-ton-mile charge in about 20 years at the present rate of traffic. It was assumed, however, that the amount of freight transportation over the road would increase each year.

ORGANIZATION AND OPERATION OF MOTOR EQUIPMENT.

By J. F. Winchester, Superintendent of Motor Vehicles, Standard Oil Co. of New Jersey, Newark, N. J.

Fundamentally, the operation of motor vehicles for profit or business purposes is like any other business—it must be organized. To make a success of a business of this type, the party venturing into it should study the various angles of the particular line he intends to pursue, and then carefully outline his course of action, with the full realization in mind that there is no line of business that presents as many possibilities for "leaks" as an unorganized motor bus or truck business.

Those who have watched the coming and going of various bus and trucking concerns in the last few years have no doubt realized that something was wrong.

MUSHROOM TRAFFIC LIGHT
AN ACCIDENT PROOF CAST STEEL
BRILLIANTLY LIGHTED
TRAFFIC MARKER
A unit that is indestructible, and even more conspicuous at night than in the day time.
It has low maintenance expense, no replacements, and is supplied with a Duplex lighting system, insuring constant service.
This unit is in use in over one hundred cities at the present time, giving perfect satisfaction.
The only cast steel unit on the market.
Bulletin on Request
Electrical & Specialty Supply Co.
MADISON TERMINAL BUILDING
Chicago, Illinois

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

My observations have led me to believe that the missing link was a lack of true appreciation of the various factors entering into an operation of this kind. These factors were lost sight of by the various interests, one of whom is the small operator, who, because of the lure of easy payments and large profits held out by various sales organizations, went into business and lasted for the time being, or while there was an abnormal demand for transportation facilities, and also by some of the larger companies, such as public utilities who have failed to realize, and do today, that through proper organization of the various factors entering into motor transportation, they are able to operate a fleet cheaper than the individual operator of one or two outfits, and through co-ordination of this type of service with the present-day facilities, such as water, steam, established express companies, or trolley service, that they are able to render to the public a modern type of service for which the public is willing to pay, in many instances, a premium, because it facilitates the transportation problem and results in a material saving of time being effected, and, in the majority of instances, within a limited radius. Transportation of this kind, through organization, can be put on a profitable and stable basis.

Consider an illustration of a haphazard installation, of which there have been many in the motor trucking industry. A business concern decides to become up-to-date; they will motorize, they study catalogues, call in salesmen, and finally decide on a certain type of vehicle because they are impressed with the looks of it or its sturdy construction, or were impressed with the promise of service that had been made by the salesman.

The machine is received, the old employe is laid off—lack of time and expense preclude the teaching of the horse-drawn vehicle driver how to operate the new outfit—and the new vehicle is placed in the hands of an experienced chauffeur. It does the work fine for a few weeks, then lack of inspection results in its having trouble, delays result, indifferent repairs are made, continual expense is entailed, and in a short time this concern feels that they have joined the class of "all going out and nothing coming in."

If this same concern was considering putting in an electric motor, a steam boiler, or some similar piece of equipment, invariably a consulting engineer or a man trained in other than sales lines, analyzes the problem and receives a fee for his services. After the machine is installed it is placed under the supervision of a competent or licensed engineer, the grade of license depending on the equipment to be handled or the skill required, and, while it may be stated that all professional chauffeurs require a license before being permitted to drive on the public highway, this license in no way indicates his skill from a mechanical standpoint, and, in many cases, because of the laxity in drivers' examinations and the possibilities of getting by through influence, a license to operate is but little indication that the party so licensed is a competent operator.

Again, compare a 5-ton installation that costs from $5,000 to $6,000, or even $7,000, and then requires an annual expenditure in some lines of work of a like amount for operation, with that new highway engineer whom you are thinking of engaging next season at a moderate salary.

You will size up his age, health, experience, personality, recommendations, and when he starts in you will advise him carefully how he should fit himself into the organization. Your bookkeeper will check his expenses and salary against certain contracts; you will measure his efficiency, and are ready to do so because you consider it good business. Have you considered the contrast between the way you and others check your investment in this human equipment, who has every incentive for efficiency, as against the inanimate piece of machinery which can only produce profits if properly supervised?

I only picture these past occurences and analyses to draw attention to the realization that organization is necessary, and further to draw attention to these let us consider the factors that enter into motor transportation enterprises, none of which can be neglected to any great degree if the outfits are to be economically operated and maintained. I know of no better presentation of them than the outline recently presented in a paper before the S. A. E. by Mr. M. C. Horine.

The factors presented by Mr. Horine cover a wide range of consideration and nesessitate a general knowledge of:

Highway engineering
Mechanical engineering
Automobile engineering
Electrical engineering
Transportation
Bookkeeping
State laws, etc.

However, Mr. Horine neglected to include the human in his table of economic factors, which I consider has an important

bearing on the efficiency of any operation. So much general knowledge is known about an automobile by the general public, yet, there are so few specialists who understand the fundamentals of the various factors that careful selection and training is necessary if the organization is to be efficient.

The organizer of a department of any size should have a knowledge of manpower, and understand the phychological elements of organization in order that harmony and team-work may prevail, without which discipline and the possibility of economical operation would be at a premium.

These specialists all co-ordinate the activities of the motor vehicle in an economical way with the rest of the business. The type and extent of the organization which one would adopt depends to a large degree on the number of vehicles to be operated and the extent of the territory which they cover.

Each type of industry, whether it be a contracting concern, silk, express or oil business, has surrounding it certain business conditions with which the supervisor of motor vehicles must be more or less familiar.

For instance, in road building it is not only necessary that a man have a general knowledge of the motor vehicle itself, but it is also necessary, if he is called upon to make an installation of any vehicle for road oil or binder distribution, that he have a general knowledge of the material to be applied by the vehicle and the various types of pumps that might be used for its application. His other general engineering knowledge would fit him to work up a design that would be suitable from a mechanical standpoint. The conditions surrounding an installation of this kind would be mounting, driving and gearing the pump so that it would be practical to operate, accessible, economical to maintain, and capable of giving the proper volume distribution for the various types of work encountered by the vehicle.

I do not presume to outline the type of organization that might fit your varying conditions. We have an organization chart which provides for the handling of approximately 1,200 to 1,300 vehicles which are operated over a widely scattered territory in the States of New Jersey, Maryland, District of Columbia, Virginia, West Virginia, North and South Carolina, and which are under centralized control.

This organization chart is the result of ten or twelve years direct experience in motor transportation, and the vehicles under this plan are being operated in direct competition with other types of transportation, namely: horse-drawn and steam. In at least 98 per cent. of the cases each outfit is doing the work, at least within a slight margin, more economically than it could be done by any other form of hauling.

Our chart indicates that the branch of the company in which these vehicles are being operated is a sales organization, and the relation of the motor vehicle department to the balance of the organization. The chart also indicates that the Superintendent of vehicles has directly under his supervision men who handle the inspection and mechanical upkeep of the outfits, and that he is responsible for the installation of the various types of motor vehicles, and, while not directly responsible himself for the vehicle operators, he is in direct touch with them through education and the auto inspectors who visit periodically all of the outfits.

The output from the vehicles is directly up to the Branch Sales Manager through the Route Foreman, and the gathering together of the reports turned in by the two departments is under the supervision of the Accounting Department.

The painting of the vehicles is done by the Construction Department, in most cases, for economic reasons. In forming a shop organization, one has to take into consideration the fact that in automobile work practically all branches of the mechanical arts are encountered. A man who superintends this work should be one who has fundamentally been educated to think along mechanical lines I prefer one who has served an apprenticeship as a machinist or tool-maker, and has educated himself along engineering lines. He may be called upon to consider problems wherein the following lines of work may have to be considered:

Designing
Pattern making
Foundry practice
Machine shop practice
Tool-making practice
Blacksmith practice
Electrical
Painting
Tinsmith
Wheelwright
Body building
Carpenter
Upholstering
Stockkeeping
Service problems, etc.

A man so equipped will be in a position

which will tend to make him resourceful and capable of instituting many short-cut methods, which will result in a large yearly saving. He should, along with his mechanical training, possess those qualities which fit him to instill in others a desire to perform their duties in a harmonious, careful and conscientious manner.

When a vehicle is to be purchased, the type of work and the country into which it is to be installed are carefully studied from the various angles pertaining to an efficient installation.

In my particular line, a canvass is made of the approximate number of gallons or packages that will be delivered in the respective territory under consideration. We study, particularly, the adaptability of the road to carry it so that we may have installed the proper transmission and rear axile ratios, tire make and sizes and take particular pains to install an outfit whose gross weight is suited for the road and bridge conditions into which it is going.

Care should be taken in studying an individual installation to make sure that it will compare from an economical standpoint with other types of transportation that are at one's command.

The matter is becoming a more complicated one yearly regarding an installation. Legal restrictions, high license fees, and general taxation necessitate a closer studying of this problem than ever before.

The question of standardization has to be studied, and while standardization can be argued for from a standpoint of making it much easier to handle the vehicles, yet, on the other hand, when a large fleet is considered, it is well not to limit the vehicles to any particular make, for the reason that you have left no direct method of comparison as between one make and another. We standardize the make in a district or a station, and try to hold a station to not more than two makes, which simplifies the service and operating problem.

After having taken into consideration the various possibilities, and it has been found feasible to make installation if goods are to be economically hauled, the largest load possible under existing conditions should be hauled, for the reason that all operating figures will show that the unit cost, such as ton-mile, etc., is materially higher where small units are used. Also, from the standpoint of general operating economy, the installation of a heavy unit is preferable to a small one, as a large unit simplifies the problem of control and handling for the reason that fewer units are required.

That the location of a machine may be determined at any time, accurate records are kept of the vehicle number and the station to which it is assigned in booklet form, and as outfits are moved from one station to another they are taken care of by "Between Station Transfer Reports."

For the ready reference of those who are directly concerned in the location of vehicles, a control board is run and all vehicles in the territory are spotted in their respective locations by numbers on this board. The make of vehicle is indicated by the shape of the cardboard on which the number is printed, which cardboard takes the form of the vehicle radiator. The type of service, such as gasoline or oil tanks, barrel or package truck, is indicated by the color of the tack head. By this control board, vehicles may be located at any time, whether they are in the shop or at the station to which they are assigned.

The shop section of the control board makes provision for showing whether the truck is in for a complete overhaul, is waiting for repairs, whether it is in our own or an outside paint shop, and the number of trucks that will be ready for service in half a day's time. Accurate record is kept of all truck movements and the time out of service for any reason.

In the operation careful study has to be made of the various factors noted. Particular care must be exercised in the selection of a driver if the operations surrounding the various factors laid down are to be successful in the selection of an operator.

In the early days, it could safely be stated that the success of a machine was largely dependent upon the operator. That is not true today, however. Some outfits will stand more abuse than others, yet it is well to select an operator who is so constituted that he has the interest of the business at heart.

An operator should have personal obligations which will tend to instill a sense of responsibility and make him careful of the equipment he operates. In my opinion, a man of 33 years of age or upward, who has a family or some other obligation, if carefully broken in from a mechanical standpoint and instructed along pertinent lines, will assist in many of the operations that make for economical deliveries.

While a general study of the various factors that enter into delivery is the duty

of the supervisor or route man, yet it is a fact that through education and co-operation, an intelligent operator will promote economical operation from many angles, particularly when he comes in contact with the public.

In an operation such as road construction, where a certain amount of skill is required in the laying of material such as asphalt or other road material, a careful, conscientious operator will, with some instruction, take on, as a matter of pride, the study of various conditions which will impress the supervising officials and relieve you of many minor duties. An operator of this kind takes pride in his work, cuts down the amount of supervision necessary, and results in greater output, accurate reports, etc.

Provision is made for the operator to have a given time each week to go over chassis, lubrication and other parts that may need attention. The operator has outlined to him the parts of the mechanism he is responsible for, which are indicated by an asterisk (*) being placed beside these items on the inspection report. When the operator encounters trouble he cannot solve he turns in one of these reports.

No vehicle should be installed and left in the hands of the operator without some provision being made for it to receive a periodical mechanical inspection. Inspection is the means of taking care of minor adjustments that are made necessary by the constant vibration and natural wear which any machine is subjected to. It provides a means for taking the "stitch in time that saves nine," and eliminates the possibilities of minor adjustments rapidly becoming worse and eventually resulting in major repairs.

The type of inspection system to employ depends to a large degree on the fleet under consideration. Our inspection force of a body of men who are first-class repair men who have the faculty and personality to instruct and assist the operators or marketing men with whom they come in contact. They are held responsible for the mechanical operation of the truck from its installation as a new unit, or after its overhaul until it is ready to be returned to the shop.

They maintain constant schedules and visit a truck periodically. One inspector will take care of from 15 to 24 vehicles, depending on the type, the amount of territory they have to cover, for it is obvious that a man can take care of a much larger number of vehicles operating from a central garage than one who has to visit a number of plants or stations.

Besides being responsible for the mechanical condition of the truck, our inspector has to examine for proficiency all men who are employed as operators. He is held responsible for any neglect which may result in our having a vehicle go on the road which presents other than a first-class appearance, and reports any irregularities and indifference exhibited toward the rules that are laid down for the motor vehicle operators' guidance.

Provisions are made to overhaul the vehicles when needed in a central repair shop. Outfits are brought in for repairs during off seasons, or are replaced by "reserve" equipment, which is held for this particular purpose. Every effort is made to plan the movement into the shop so that the outfit will receive prompt attention. The progress of the work is checked by a weekly Shop Report which materially assists in checking up the shop activities and provides an index of work accomplished.

To obtain the most economical results, it is best to adopt the unit repair basis. This provides for the carrying of a number of complete units which can be readily substituted for the worn parts, and the worn parts can be undergoing repairs after the chasis is in the paint shop or on the road.

The shops are divided into departments, such as chassis, motor, gear box, rear axles, electrical and overhaul, and a competent specialist is engaged for these respective duties. As a department grows, the old employe should be worked into a position of working foreman. This training should fit him to assume greater responsibilities. I find that more accurate and economical results are obtained under this method than by permitting a man to do all-round work, and, besides, through this system it is possible to detect the source of poor workmanship or failures.

Inspection is provided in each department through the activities of the foreman and final inspection of the complete job is provided for by a man who is entirely responsible to the Superintendent alone for the passing out of work.

Necessarily in an organization of this kind emergency service has to be provided. This is done by carrying a stock of parts at the main repair shop, and in small quantities at strategically located points. At the main station this stockroom provides for the shop needs, which facilitates repairs. In any organization

where constant service by the vehicle is an asset, an efficient stock or service depot is a wonderful thing. It provides a means for filling wants in any emergency which places the vehicle in a position to operate at all time.

To provide proper service it is necessary that correct mechanical information be kept on file, and changes in the mechanical condition of a vehicle kept up to date. We provide for this by the vehicle manufacturer, which is filed with a standard mechanical information sheet. If these records are properly maintained the service man has a ready reference for each vehicle, whih will remove a great possibility of incorrect parts being supplied.

A well kept truck should be kept painted periodically. Paint protects the wood and metal surfaces from the elements, and provides a means for increasing the value of the vehicle by making it a traveling advertisement. As I travel I am often surprised to note that some concerns pay many dollars for select sign locations along highways, etc., and then neglect their motor equipment. If advertising pays, I can concieve of no better medium than a well-kept vehicle which daily encounters many more people than the average signboard.

A Paint Shop should be well ventilated, have dust proof varnish rooms, and have facilities for rapid drying, although some wonderful results are accomplished along these lines by small shops with limited facilities.

That the officials may know just what each vehicle is doing, and be provided with a basis of comparison with other mediums of transportation, accounting is necessary. Any system should be as simple as possible, yet provide a clear and distinct method of comparison. We do this by summarizing our entire figures on a suitable sheet. This form analyzes where the money is spent on the vehicle, and the results are shown in groups, by makes, capacity, style of service, and year of installation. It is a progressive record from which can be determined a group performance after a number of years' service as compared with its first year. This is a semi-annual report.

Care is taken through a carefully prepared primer, to see that proper distribution of charges are made.

To complete this report necessitates a group of auxillary forms, some of which show in minute detail the efficiency of the Department, or work being performed. These include:

Delivery,
Mileage Run,
Gasoline Consumption,
Stock-keeping Records,
Analysis of Distribution in the Central Shop,
Analysis of Inspectors' Time and Expenses,
Tire Records,

and others from which we can minutely dissect the vehicle's efficiency from any angle that might be required.

We do no unnecessary work; for instance, no mention is made on our form of Cost per ton mile, but if for any reason this is desired, we can work out a particular example from the information at hand.

Accurate records are kept of the various types of tires used. Tires are bought on an adjustment, or on a guaranteed price per mile basis. In order that the tires may be properly adjusted and that we may be in a position to compare the relative merits of one make with another, it is necessary that these records be maintained.

Provision is made for taking care of the various types of tire equipment. In the case of solid or cushion tire equipment, a report is made when a tire is applied and its record is kept in the office on the solid tire record. In the case of solid or cushion tires, when once applied to a wheel, they remain there until finally worn out, with but few exceptions. These records are easy to keep as compared with those necessary for pneumatic tires.

Pneumatic tires, which are apt to come to grief through puncture, etc., require more detailed care on the part of the operator, and to assist him in keeping proper records we supply a definite set of forms. These forms facilitate the operator keeping an accurate record, and when a tire is sent in to a central stock room to be adjusted, it is taken care of through a special form of tag, which is used as a shipping and mailing tag. This tag is so arranged that it can be torn in sections when about to be used, and one of the stubs, bearing the same serial number as that part which has been sent through the mail and on the tire, is retained by the operator. Through this tag we are able to check shipments and mileage very accurately.

While it may seem to some that the expense involved is not justified, my experience clearly shows that accurate re-

cords of this description should be kept. It is surprising to note the large saving that can be effected with some types of tires as compared with others, both from a standpoint of Tire Cost per Mile, and Mechanical or Repair Cost per Mile.

A summary of the mileage obtained from all tires is made up semi-montbly and turned in to headquarters. These records give us a comparison between the different types and makes of tires.

Provision is made through these detailed reports, for the various executives of the organization to keep in intimate touch, through analytical forms.

Accounting forms may be obtained economically from various sources, and in the majority of instances under standard methods laid down it will be found that approximately two-thirds of the charges are socalled "Fixed Charges," and one-third "Variable Charges."

I call this to your attention, because if economy is obtained, the Moving Load and Active Factors are the ones which should receive close attention. Because a vehicle is a mechanical device these are often overlooked, and great stress is laid upon the maintenance and up-keep factors. These latter factors in modern machines will remain practically constant, provided speeding and overloading are eliminated.

The problem of material transfers and interurban delivery by motor truck, and the feasibility of employing motor buses is becoming more generally recognized by some of the larger companies. This is indicated by the desire of some of the larger old line railroads and transportation companies having in mind the adoption of unit carriers, which can readily be transferred to motor vehicles. One such installation, I understand, is being made by the Erie R. R. for the transfer of material between its Jersey City yards and New York City, and I believe other railroads have similar installations in mind. Traction companies are realizing that the buses can be adopted with profit, to act as feeders for its main trolley lines. These installations are being made only after careful study of all angles pertaining to the problem, and there is no doubt but what the future will bring forth a considerable growth along these lines. The possibilities of this type of transportation call for greater co-operation among all affected, and the industry as a whole should not be judged by past performances of many irresponsible operators, who, because of selfish interests, have not taken into consideration the rights of the public at large, which resulted in abuses springing up that have caused a general feeling of hostility towards this type of transportation. There is need for a greater co-operation if the operating problem is to be satisfactorily solved. Excessive taxation and restrictive laws which seem to be springing into existence over the country, will only result in the throttling of an industry, which is yet in its infancy.

The foregoing matter is from a paper by Mr. Winchester presented at the recent annual meeting of the New Jersey State Highway association.

MOTOR TRUCK NEWS NOTES

Danger of Red Tail Lights

The use of red for tail lights on automobiles is deprecated in an article in The Railway Age. This color, it is argued, should be restricted for use at extra dangerous locations, such as railway crossings, boulevard crossings and at places where material is piled in the streets. When an automobile driver follows red lights for mile after mile, it is said, the monotony nullifies their effect as a danger signal.

An accident occurred in which the chauffeur said he had been following the red lights of cars ahead, and when he approached a railway crossing he took it for granted that the lights on the gates were those of an automobile. He turned out to pass the supposed car, ran through the gates and was struck by a train. The remedy suggested by The Railway Age is the use of yellow tail lights for automobiles.

Detroit Fire Department Fully Motorized

Fifteen years ago all of Detroit's fire apparatus was horse drawn. On April 10th the last horse-drawn vehicles were discarded, the horses sold and now Detroit's Fire Department is completely motorized. There are those who sentimentally say, "Too bad to shelve such intelligent animals," but efficiency and prodence answer that motor equipment is the only modern way to fight fires. Time element is everything, and the 10 extra minutes on the way to the fire may mean untold loss.

Novel Method of Removing Snow From Paved Streets in Salt Lake City

During the past winter immediately after the bulk of the snow had been removed from the paved streets in the busi-

ness district, by means of snow plows attached to motor trucks, a very novel but thorough method of freeing the pavement from snow was put into operation. Five flusher tanks each with a capacity of about 1,000 to 1,200 gals. were used.

Commissioner of Streets Burton had noticed each winter that the overflow of warm water from the City's Hot Springs, located about 1¼ miles north of the business center, entirely cleared the pavement of snow and ice. He conceived the idea that it would be entirely feasible to load the hot water into tanks and with the short haul use it to advantage in clearing the snow and ice from the pavements in the business district.

This idea was put into practice with splendid results. Within 24 hours after the heaviest snow storm experienced during the past winter, when the temperature was around the zero mark, the main thoroughfares were completely and thoroughly cleared of snow by the use of the snow plows and the hot water flushers. The water has a temperature of about 110 degs. when it leaves the flushing tanks under a high pressure. With five tanks in operation almost a continuous stream of hot water is kept playing on the snow until the streets are clear.

The entire cost of this work for December, 1921, and January and February, 1922, an unusually hard winter, was a little under $6,000 per month. The old method of hauling the snow from the street intersections only was nearly as expensive as this complete operation.

Cost of Road Dragging by Truck in South Dakota

Douglas County, South Dakota, dragged 1,507 miles of road with an FWD 3-ton truck and a large drag during the summer months of 1921. The following figures show the comparative costs of doing the job with a truck and hiring it done with a tractor.

WORK DONE

Miles per gallon gas..	1.9
Miles per gallon oil..	35.8
Miles dragged	1507
Gallons of gas used...	787
Gallons of oil used...	42

This work was all done in low gear, hence the low mileages.

COST PER MILE

Gasoline	$ .12
Oil	.02
Driver	.185
Repairs	.032
	$ .357
Cost per mile with hired tractors.	1.25
Saving per mile using trucks.....	$ .893

The total saving on this job was $1,345.75.

STATE BRICK PAVEMENT SECTION ON NATIONAL HIGHWAY IN INDIANA.

Contract for the construction of the first brick road in Indiana to be built under the direction of the State Highway Department has just been let at a cost of $219,916.78. Indiana was one of the last states in the union to establish a highway department, and while many miles of brick roads have been constructed in the past by the various counties, the contract just let is the first action of this kind by the state.

The section to be paved with brick is 6.897 miles long and extends from Putnamville to a point 1½ miles east of Mt. Meridian. It is a part of the old National Road which runs entirely across the state, extending from Cumberland, Maryland to Jefferson City, Missouri, and is the principal traffic route between Indianapolis and Terre Haute.

When the National government planked the road west of Indianapolis with white oak in the neighborhood of 75 years ago, vitrified paving brick as they are now known and manufactured, did not exist in this country. Had they existed Indiana motorists today might be rolling along over brick roads nearly a century old as they are in Holland, where such roads, still in service, were build by Napoleon.

Decision of the state highway department to use vitrified brick on this road is in accordance with the recent announcement by Governor W. T. McCray to the effect that brick roads would be included in this year's program.

The bid for brick is $111,916.78 more than the low bid for concrete on this section. The design calls for a 5 in. concrete base, 3 in. vertical fiber brick and asphalt filler. The work will be done by the Carpenter Construction Company, of Terre Haute, Ind.

A CORRECTION

Mr. John L. Hershey, author of the article entitled "Making Irrigation Bonds Saleable," which was published on pages 135-137 of the April issue of this magazine, has called attention to a numerical error in the article as published. In the paragraph relative to possible extension of the boundaries of the district on which bonds could not be sold (see page 137) the acreage should have been 2,000 to 3,000 instead of 3,000 to 4,000.

Kentucky Rock Asphalt

Builds highest type asphalt roads and streets at a reasonable cost.

A perfect sheet asphalt mixed by nature.

Laid cold on any good base.

No binder course or curb required.

No heating or mixing plant or skilled asphalt workers necessary.

Laid in one course and opened to traffic immediately after rolling.

Not susceptible to damage from the weather.

Adopted by ten states in standard specifications.

In use on Lincoln, Dixie, Jackson Highways and National Road.

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Ask for Booklet E.

Kentucky Rock Asphalt Co.

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EDITORIAL

ENGINEERING LEADERSHIP

Not many years ago the engineer, with some exceptions, was such a thoroughgoing servant that he seldom even sought the form of leadership for which he has always been well equipped. He waited, in a figurative sense, for someone to touch him on the shoulder and say: "I can use you." He shunned direct contact with the public, saying, with a gesture of disparagement and a catch in his voice, that he was "not a politician." But the day came when he began to tire of his self-imposed minor role. He then became vocal in his discontent, but for a considerable period of years did not go beyond his profession for an audience. Discovering, at length, that commiseration has its limitations and that it profited him little to "trouble deaf heaven with his bootless cries," he decided to get into the game and become a leader; to become a master while remaining, in the best sense, a servant.

A very pleasant contrast with the attitude of former generations of engineers, toward engineering questions before the public, was recently presented in Kansas City, Missouri. After the failure, in 1921, of the eleven-million-dollar water bond project for Kansas City, The Engineers' Club of that city, conceived the plan of conducting an educational campaign in a further effort to carry the bond issue, which was urgently needed to pay for new filtration works, two pumping stations, larger feeder mains, reservoirs and other work. The club presented engineering facts and figures to the 170 civic organizations to help the public vote intelligently on the project. A special committee of eleven engineers conducted the educational work and by using modern publicity methods sold this great engineering project to the public. A detailed account of the methods they used is published in the present issue of this magazine.

This is a very good example of engineering leadership. Opportunities for public service of this sort arise from time to time in every community. These facts lead to a wholesome and regenerating conclusion which the individual engineer can be depended upon to reach without the aid of a diagram.

EFFECT OF CORE DRILLING ON PAVEMENT PRICES

A comparatively recent development in the pavement construction field is the use of a core drill for determining the exact thickness of pavements as a means of checking up the degree of faithfulness, or success, of the contractor in carrying out the provisions of the specifications. These drills are being used by several of the state highway departments. A brief but illuminating article in this issue tells how the use of one of these drills caused the contractor to waive claim to compensation on a section of new concrete road that was not up to the prescribed thickness. It is very significant to note that not only was the contractor penalized in the manner described, but the engineers and inspectors in immediate charge of this piece of construction were discharged.

The core drill is a useful machine on many classes of work and it doubtless has its legitimate uses in connection with highway construction, especially in testing the finished pavement. But those long familiar with practical construction difficulties, notably the clashes between strict engineers and hard pressed contractors, will perceive in this use of the core drill some rather unhappy possibilities. It may be fine in theory but not so good in practice.

In the past engineers have specified the pavement thickness and engineers and contractors have, as a rule, taken all reasonable precautions to insure the substantial attainment of the specified depth. Of course, since pavement construction is not an exact science, depths have varied both ways from the prescribed figure. The introduction of the core drill as a pavement depth testing device raises a serious question as to whether engineers, in their praiseworthy efforts to secure good construction, have not overreached themselves.

All should agree that the engineer who intends to use the core test before paying for a pavement should make that fact very clear in his specifications. The contractor should be warned in advance of this new hazard in his already very difficult and hazardous calling. The method of making the tests should be made

known to the contractor before he starts to build and he should also be told just what interpretation will be placed on the test data and how these interpretations will affect the payments due him. If in addition to this information he knows the disposition of the engineer he will be sufficiently warned so that he can safeguard his interests in making out his bid and in conducting the construction operation.

If the engineer is inclined to be liberal in his interpretations of specifications, making due allowance for inevitable variations from prescribed standards, the contractor will not be greatly worried by the core test. But if the engineer is of the "strict" type the contractor will sense impending disaster if the finished slab is too thin in places and he naturally will increase his bid prices so as to give himself what might be termed "rejection insurance" and at the same time to compensate him for the excess depth which he, as a practical man, knows will surely result from the effort to have the slab of full specified depth at all points. In general the contractor will be inclined, if he follows his best judgment, to bid higher on a core drill job than on one where this acceptance test is not to be used, no matter how sure he may be of the fairness of the chief engineer. This is due to the fact that the contractor's direct contact with the engineering department is through young men who are not only inclined to be overinsistent on the attainment of perfection, but who are themselves afraid of what the core drill may exhume. If a thin slab means that the engineers and inspectors on the job are to be discharged the contractors are in for a hot summer.

Unless, therefore, it is made plain and clear in advance that the core drill test will be used mercifully and with discretion and common sense, it will surely increase pavement prices. What a state may save on one "gift" pavement it is likely to pay back with very high interest on subsequent contracts. The legitimate uses of the test would seem to be confined to the detection of deliberate dishonesty or crass incompetency.

A SATISFACTORY SOLUTION OF THE "EXTRA WORK" PROBLEM

In an exceptionally well considered and well written article in this issue, a city engineer describes a system he has devised and successfully employed in handling "extra work" charges on construction contracts. This covers one of the points most often at issue in this field, so the article is of permanent interest and value to every engineer, contractor and public official. The author's very evident desire to deal fairly with the contractor is the fundamental on which his procedure is based. but at the same time full protection of the interests of the public is secured.

It is most encouraging to note the ever-increasing good will between engineers and contractors. This is due to many things, of course. Engineers are becoming more practical and more specific and this enables the contractor to become more ethical and more honest. It has been discovered that the contractor is naturally inclined to be honest and he will be honest unless harried into dishonesty either by the vagaries or exactions of the engineer or the desire of some public officials to make political capital out of his ruination.

The system described is simple as well as satisfactory. Any local authority could use it to advantage. Its success rests on its straightforward attempt at full understanding based on clearly drawn and fairly interpreted specifications and on carefully kept records and written orders.

During the six years this system has been in operation in an important city, only one dispute has arisen as to payment for extra work, and in that case the system was fully vindicated, as the contractor abandoned his claim on the advice of his attorney. This is an impressive record and convincing evidence of the worth of the system described.

A ZONING GUIDE

The United States Department of Commerce, Washington, D. C., in response to the needs of over sixty cities in which zoning is now in effect, and of over 110 cities which have zoning ordinances in preparation, has just issued a Selected Bibliography on Zoning. This contains critical references to the most important published articles on the subject. Special sections are devoted to the arguments for and against zoning, to the legal aspects of zoning, and to such technical matters as the relation of city planning to zoning, the different types of districts, and agencies and administration for zoning. The bibliography may be obtained by application to the Division of Building and Housing.

HANDLING "EXTRA WORK" CHARGES ON CONSTRUCTION CONTRACTS

By W. Earl Weller, City Engineer, City Hall, Binghamton, New York.

Owing to a deep seated conviction among engineers that contractors will take advantage of any extra work provision in a contract, and owing to the even deeper seated conviction among the public at large that extra work is indicative at best of carelessness on the part of the engineer, extra work has grown to be the *bete noir* of all engineering construction. That this condition is unfortunate in its influence, on public work especially, and that it should be corrected all municipal engineers will admit. Perhaps they will not so willingly admit that the remedy lies wholly in the engineer. Such, however, is the fact.

The problem for the engineer in this case is a double-barreled one. First, he must convince himself as to the unvarying truth of that fundamental economic precept that "we pay for whatever we get"; and second, he must devise a system of extra work accounting that will be both simple and accurate. It is the first of these considerations that is the real stumbling block, although engineers are most likely to hide behind the plea that it is impossible to find a system of accounting that will be simple enough for the average time-keeper or inspector and yet accurate enough to be dependable.

Author's Conclusions With Respect to Extra Work

Not being blessed with the mind of an advocate, the writer will dismiss the first and most difficult part of the problem with a mere statement of a few conclusions that he has reached and on which he hangs his whole policy as regards extra work. The following sentences therefore embody the belief of the writer and are more or less in the nature of a creed. Each sentence might begin with a credo but that would scarcely suit an engineering discussion. However, the writer does believe implicitly as follows:

First: That contracting is a legitimate and honorable type of business and that a contractor is entitled to a fair profit on his sales.

Second: That a contractor cannot in common fairness be expected to know more about a piece of work on which he is bidding than the engineer who designed it.

Third: That the drawing of plans and specifications so exact as honestly to eliminate any unexpected work is a useless waste of time, effort and funds.

Fourth: That general clauses in a specification which may be stretched to cover conditions that the engineer did not definitely know existed are neither good engineering nor good sportsmanship.

Fifth: That the engineer is in no way concerned with the methods used by the contractor but only with the materials used and results obtained.

Sixth: That the real test as to whether or not disputed work is "work evidently not contemplated by this contract" is whether or not the engineer himself really foresaw the contingency and gave

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EXTRA WORK ORDER

Order No. Inspector Date

In connection with your work on you are hereby directed to

You will be paid for this work under Sec. Page of your contract with the City.

Deputy City Engineer.

Form 501

FIG. 1—FORM FOR ISSUING WRITTEN ORDER FOR "EXTRA WORK" ON BINGHAMTON, N. Y., CONSTRUCTION CONTRACTS.

the contractor the opportunity to include the cost of the work in his bid.

Seventh: That the engineer who has the reputation of being unfair ("strict"—engineers prefer to call it) in his interpretation of extra work pays more in the end than the engineer who has the reputation of playing square.

Simple and Satisfactory Accounting System on "Extra Work"

These rather dogmatic statements are submitted without proof or argument. The second consideration of the main problem; that is, the devising of a satisfactory accounting system for extra work, is very simple and the following description of a system which has been in successful operation for six years may perhaps be taken as sufficient proof of this simplicity.

not include any charge for the use of tools, superintendence, engineering, or the like. In case of extra work an extension of time will be granted as provided in the case of alterations."

Extra Work Written Order

This paragraph is scrupulously followed and contractors have come to recognize that they must have a proper written order for extra work if they expect to be paid for the work. Extra work orders on a proper form (See Fig. 1) are issued in triplicate for any extra work that may seem necessary or desirable. For each job the orders are numbered consecutively, are dated and are directed to the contractor. One copy of the order is retained in the office, the second copy is given to the contractor and the third copy to the inspector.

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LABOR

No. Men	CLASS	HOURS	RATE	AMOUNT	

Nature of Work

Street

Order No.

Date

EXTRA WORK REPORT

Form 401

FIG. 2—FORM FOR DAILY REPORTING LABOR ON "EXTRA WORK," BINGHAMTON, N. Y.

The standard contract form of the City of Binghamton includes the following clause—"Extra Work. The party of the second part agrees to do all extra work that may be ordered in writing by the engineer. In this connection 'Extra Work' shall be taken to mean work evidently not contemplated by the contract. The Contractor shall accept as his compensation for such extra work the actual cost of the said work plus 15 per cent, for profit, use of tools, etc. The 'actual cost' of the work shall be taken to mean the cost to the Contractor of the labor and materials actually entering into the work, togetherwith the cost of all insurance on such labor and an allowance or rental for such machinery as may be used in the work. The 'actual cost' of the work shall

Extra Work Report Form

Any work performed under an extra work order is reported each day on an extra work report form (See Figs. 2 and 3). This report embodies the number of the extra work order, the date the work was performed, the name of the job and the nature of the work, as well as an itemized statement of all labor and material entering into and chargeable against the order. It must be borne in mind that one extra work report covers only the work done under one extra work order and on one working day. If five pieces of extra work have been authorized on one job and the contractor's forces had done some work on each of these orders during any one working day the Engineer's office will receive five extra work

reports covering the five separate orders. Each of these extra work reports must be signed by the contractor or by his responsible superintendent and by the Inspector before they are forwarded to the office. When the work covered by any extra work order is completed the inspector notes the completion on his regular daily report and forwards to the office with the last extra work report his copy of the extra work order. This informs the office that that order is complete and in shape to be checked and entered on the proper estimate forms for payment.

One Dispute in Six Years

During the six years that this system of accounting for extra work has been in use in Binghamton there has been but one dispute over payment for extra work. In that instance the contractor claimed that he was underpaid to the extent of some $300 and presented his time books and bills to substantiate his claim. The Bureau of Engineering was in a position to show signed extra work reports covering the work, indicating an expenditure of approximately $400 instead of the $700 claimed. Acting on the advice of his lawyer, the contractor accepted the amount shown on the extra work reports, thereby closing the incident to the entire credit of the system.

Extra work orders and extra work reports are printed on sheets having a distinctive color and of the same size as the standard specification sheets and other report forms. This size is so chosen that the inspector can carry the forms in a suitable binder which will fit readily into his pocket. The system surely answers all conditions imposed by convenience and simplicity and the mere statement of the fact that it has operated successfully for six years seems the best recommendation as to its accuracy.

Approved..... City Engineer

Signed..... Inspector

Signed..... Contractor

MATERIALS

Quantity	KIND	PRICE	AMOUNT	

FIG. 3—FORM FOR DAILY REPORTING MATERIALS USED ON "EXTRA WORK," BINGHAMTON, N. Y.

ENGINEERS CONDUCT SUCCESSFUL EDUCATIONAL BOND CAMPAIGN

By Robert E. McDonnell, of Burns & McDonnell Engineering Co., Consulting Engineers, Interstate Bldg., Kansas City, Mo.

After the failure in 1921 of the $11,000,000 water bond project for Kansas City, The Engineers' Club of Kansas City conceived the plan of conducting an educational campaign in a further effort to carry the bonds, which were urgently needed for a new filtration works, two pumping stations, larger feeder mains, reservoirs and other work. The President of the Engineers' Club is Alexander Maitland, Jr. He is also Chairman of the new Water Commission. This bi-partisan commission of four men was elected in 1921 to handle the entire new construction and also to operate the present works, thereby removing it from political control. As many engineering questions were involved, it was thought proper to have the Engineers' Club present engineering facts, figures, costs and other data before the 170 civic organizations so that the public could intelligently vote on the project.

Mr. Maitland, President of the Engineers' Club, appointed a water committee

of eleven engineers, with Mr. R. E. McDonnell, Consulting Engineer, as Chairman. This committee arranged its subcommittees on: Statistics, Filtration, Fire Protection, Typhoid, Present Works, Ozark Supply, Missouri River Supply, Publicity, Speakers, etc., and proceeded to collect and assemble diagrams, data, stereopticon slides, newspaper articles and other information for use before civic and community meetings.

Preliminary to the campaign, a successful effort was made to eliminate all other bond projects, for at the former election defeat was due in a large measure to having eighteen other bond projects up for voting along with the water works. A City campaign was in progress and before political platforms were made public, the leaders of each party were induced to insert a plank favorable to the water works.

After nomination the candidates were pledged to support the bond project.

Prizes were given for water bond slogans; some presented were: "Water the Town and Watch It Grow," "Millions for Water Means Water for a Million," "H2O Let's Go." These were put in windows and upon wind shields of automobiles. The Engineers' Club discovered that its membership contained many speakers of ability and illustrated talks were given before about 60 of the larger civic organizations. The campaign was also conducted through the schools by talks, first before all the teachers of the City, then before High Schools and Civics Classes. Several thousand High School and Grade School students themselves made four-minute talks upon the water works needs at classes and four-minute talks upon the water works needs before their parents at their homes.

A feature of the proposed improvements was filtration and the typhoid rates of cities with filtered water were compared with that of Kansas City, which was found to be the largest city in the United States using river water without filtration. Diagrams and statistics were circulated at meetings, showing the health improvement in other cities after filtration.

The partial water softening proposed in the new plant was a campaign hit and was made effective by the speakers giving soap demonstrations with soft water and with the hard water. It was shown that the saving in soap alone would pay the entire bond interest. Demonstrations before audiences of women were both convincing and effective by showing the results of using hard water and then soft water, in washing linens, laces, lingerie, etc.

Records were secured of the people voting at the 1921 election and it was found that only from 7 to 8 percent of the membership of civic organizations voted at all. The voting record of each civic club at the previous election was publicly presented, much to their embarrassment and humiliation, for it was found that the clubs were strong on civic duty but sadly delinquent when it came to voting. This feature of the campaign was effective in getting out a large vote.

The results of the campaign showed a vote of over 40,000 majority and as a direct result it was found that in one ward where the water works subject was specially well covered, the vote was 8 to 1 for, while in wards without talks, the bare majority vote was secured.

One beneficial result to the Engineers' Club was the bringing of the engineers prominently before the public in a worthy civic duty performed in behalf of their city.

ESTIMATING COST OF HIGHWAY BRIDGES

By Walter S. Todd, Assistant Bridge Engineer, Illinois Division of Highways, State House, Springfield, Ill.

A good estimate is one which approaches very closely to the actual cost of construction, with a fair profit to the contractor included. In order to secure accurate estimates, actual cost records of similar work should be available to the estimator.

There are two factors which have made it difficult to secure reliable estimates on highway bridges; first, the construction of bridges of the types now common, and by the methods now prevalent is comparatively recent, so that cost records are not available which are applicable to present types and methods of construction. Second, the securing of actual costs while construction is in progress involves extra work upon the engineer in charge of the work, and, consequently is generally slighted. The time and energy required to "boil down" cost records to a unit basis, so that it may be used on similar work for estimating purposes, is very great. The results obtained, however, are worth the effort and form a basis for estimating.

Preliminary Estimate.

There are two kinds of estimates,—preliminary and final, and each has its particular field of usefulness. A preliml-

nary estimate may be based upon approximate data, but with sufficient information at hand, it should not vary greatly from an estimate which is made after the detail plans are complete. A preliminary estimate may be based upon plans for structures of a similar nature which have already been prepared, or upon standard plans. Curves may be prepared which show the relation between size of structure and volume of material required, and the amount of material required for a given structure quickly obtained from them. The preliminary estimate has three distinct uses. It may be used to determine the most economical span length to adopt for a multiple span structure. It may be used in reconnaissance for determining the most economical route to choose between two fixed objectives, i. e., the cost of earth work, pavement and bridges on one route may be compared with the same items on another possible route. The preliminary estimate permits the determination of the approximate cost of structures without the aid of complete plans. An estimate of this kind is also essential to present a definite basis for a campaign to secure funds to finance construction, and is generally demanded before completed plans are available.

Final Estimate.

The final estimate is made after surveys and plans are completed, and should represent the engineer's best judgment regarding a reasonable final cost of the structure to the public or owner. An estimate may be quite accurately made if it is subdivided into the various items of material, labor, transportation, etc., which are involved in the construction. As an example, the following items are covered in an estimate for a reinforced concrete bridge, and each item is given in terms of 1 cubic yd. of concrete in the finished structure: (1) cement equals the number of barrels per yard of concrete multiplied by the sum of the cost of cement f. o. b. nearest station, and the hauling cost from station to bridge site; (2) fine aggregate equals volume of sand per yard of concrete multiplied by the sum of the cost of sand f. o. b. nearest station and the hauling cost; (3) coarse aggregate equals volume of stone or gravel per yard of concrete multiplied by the sum of the cost of coarse aggregate f. o. b. station and the cost of hauling same; (4) form and falsework lumber; (5) labor required in placing forms and falsework; (6) labor required in mixing, conveying and spading concrete; (7) reinforcing steel delivered at the bridge site; (8) labor in bending and placing steel; (9) removal of existing bridge; (10) excavation cost per cubic yard of concrete; (11) incidentals such as name plate, expansion device or brick for hand rails, when used. The sum of these items may then be multiplied by the total yardage in the structure and a percentage added to same to cover liability insurance, profit, contingencies, superintendence and overhead.

It is generally best to add the cost of piling as a separate item, as the cost of this part of the work is not generally accurately known in advance. The contractor may be instructed to submit a unit bid and payment may be made upon the lineal feet actually driven.

Cost Data.

It is a comparatively simple matter to determine the quantities of material required for a structure, but the cost of labor is best determined from previous work of a similar nature. These labor costs should preferably be in terms of man-hours, so that variations in labor rates may be easily applied. The bridge office of the Division of Highways of Illinois has kept records of labor costs for a large number of highway bridges of various types which have been built from standard plans. These average costs in terms of man-hours per cubic yard of concrete in the finished structure are given in Table I with the number of bridges of each type from which cost records were taken to obtain the average given. Bridges on which labor items were exceedingly high or low were not included, so that the figures shown give a fairly reliable average under usual conditions for the

TABLE 1—COST DATA FOR REINFORCED CONCRETE HIGHWAY BRIDGES.

Type of Structure	R. C. Box	Slab Bridge	Thru Girder Bridge	Deck Girder Bridge	Plain Concrete Abutments
No. of Bridges Considered	83	93	48	3	5
Man-hours per cubic yard of Concrete					
Bldg. Forms	4.24	4.41	4.71	7.04	2.69
Mixing and Placing Conc.	3.97	4.65	4.33	3.87	3.45
Bending and Placing Steel	0.68	0.75	1.51	1.24	
Feet B. M. per Cubic Yard of Concrete					
Form and Falsework Lumber	24.20	16.53	17.54	20.23	10.00
Pounds per Cubic Yard of Concrete					
Av. amt. Reinforcing Steel in Superstructure	100	198	230	255	
And Substructure	100	44	53	57	

State of Illinois as a whole. The amount of form and falsework lumber required is also shown in the table, but these figures are probably low, as the falsework used was generally green timber cut near the bridge site and was not included in the figures shown.

In Table I all structures considered had reinforced concrete abutments, with the exception of the structures listed in the last column.

In the estimate of the cost of structural steel superstructures, the principle of dividing the estimate into the various labor, material and transportation costs is advisable. The chief items involved, exclusive of floor, in the cost of a steel truss are as follows: mill or warehouse price of structural shapes; freight from mill or warehouse to fabricating shop; fabrication costs, including detail plans, reaming, shop paint; freight from the fabricating shop to station nearest site; unloading and hauling to the proposed site; falsework; erecting; field riveting; field painting; liability insurance; profit and contingencies.

The foregoing paper by Mr. Todd was delivered before the recent Short Course in Highway Engineering at the University of Illinois.

MUNICIPAL SANITARY PRECAUTIONS DURING EPIDEMIC OF INFLUENZA

Rambling Thoughts of a Civil Engineer

PART TWO.

By Dr. Wm. Paul Gerhard, C. E., Consulting Engineer, 17 *West 42d St., New York, N. Y.*

The measures of public hygiene and sanitation, to be instituted by municipalities, which seem to me to be, one and all, worthy of consideration, follow. No attempt is made, in this enumeration, to put them down in the order of their relative importance, for on this point the individual views of experts vary.

Municipal departments (health, police, city engineering and public traffic departments) should hold in readiness well-considered preventive measures. The extent and nature of these necessarily depend upon the character of the community. A rural district, or a small town, obviously, demand a somewhat different treatment than a metropolis.

In all important measures efforts are concentrated upon:

(a) The prevention of droplet infection by sneezing, coughing, spitting, handshaking, etc. Such droplets are scattered about to a distance of several feet, and every drop may carry the germ.

(b) The control of the sputum, the avoidance of hand contamination, and the contamination of eating and drinking utensils (dishes, glasses, cups, spoons, etc.).

(c) Efficient organization, providing for the gathering of facts regarding cases and mortality, and preparing "pin maps" both of cases of illness and of deaths; studying the collected data; requiring notification by physicians; sending sanitary inspectors to follow up the cases reported, making a house-to-house inspection of the entire city.

(d) Careful instruction of the general public, of teachers in schools, of foremen in factories, of superintendents of large department stores, of theatrical managers, etc., in nose and mouth hygiene* by means of bulletins, pamphlets and popularly written literature.

(e) Prompt destruction of all infectious matter; warning against a careless disposal of nasal discharges.

Equally important administrative control measures, to be taken at the first outbreak of an epidemic are: the isolation of the sick; the provision of a sufficient number of hospital beds; the avoidance of crowded gatherings, and the efficient warming (in winter) and ventilation of homes, offices, stores, workshops, and means of communication.

These rather general considerations are necessary for a proper understanding of the more specific measures outlined in the following suggestions.

---

* Among *Rules for Personal Hygiene*, most of which are not considered in this article I briefly mention:

Avoid people who are coughing or sneezing.

Keep at some distance from persons talking or singing.

Do not attend crowded gatherings, whether indoors or outdoors.

When obliged to cough or sneeze, cover nose and mouth with handkerchief.

Avoid the promiscous use of handkerchiefs, towels, napkins. Also shun roller towels, soap in cake form, drinking cups in public places.

Never use cup, glass or dish used by others unless utensils have been washed and sterilized.

Wash hands before eating, and after handling pencils or other articles used in common.

Work, live and sleep in well-ventilated rooms.

Keep the feet dry, the body warm, avoid physical or nervous exhaustion.

Take moderate daily exercise; regulate the hours of sleep.

If you become unavoidably exposed, and are threatened with the "flu," go at once to bed. Stay in bed until the fever subsides, in order to avoid a relapse or later complications.

A. POLICE AND HEALTH BOARD REGULATIONS

1. *Anti-spitting Ordinance.*—Pass an anti-spitting ordinance, making spitting in public places or on the street, a punishable misdemeanor. Provide an adequate force of sanitary inspectors, or policemen of the sanitary squad, to enforce the ordinance.

2. *Placards Regarding Use of Handkerchief.*—Put up placards, printed in large letters, in public buildings, on prominent street corners, on public squares and in public conveyances, warning the public that there must be no "open" or unguarded coughing or sneezing, and recommending the use of a handkerchief, or some suitable substitute, when sneezing, coughing or expectorating. This measure is recommended in order to smother a cough or sneeze which may contain the germ. Make it a misdemeanor to do this in public without covering up mouth and nose with a handkerchief or paper napkin.

NOTE—The health bookmarks sent out by the Department of Health of New-York City some years ago, some of which had printed on them warning tell-tale illustrations as to the use of a handkerchief, are to be recommended.

3. *Use of Suitable Substitute for the Handkerchief.*—Urge the use of strips of cheese cloth, or cheap muslin, or of paper towels or napkins, in place of handkerchiefs, and recommend destroying them after use by burning, this being vastly better than sending infected handkerchiefs to a public laundry. Print such warnings in the daily press. Distribute leaflets to this effect in dwellings, apartment and tenement houses, in stores, factories, drugstores, etc.

4. *Prohibit Common Drinking Cups and Roller Towels.*—Common drinking cups and roller towels should be strictly prohibited. Where they still exist, their use should be avoided.

5. *Visitors to Sick in Hospitals.*—Permit no visitors in the city hospitals. Where an exception to this general rule is granted, the visitor should be made to wear a suitable new face mask. (See under 11.)

6. *Placard Houses.*—All houses where cases of influenza occur should be placarded by red cards, printed in bold-face type.

7. *Funerals.*—All public funeral services should be prohibited. The attendance at home funerals should be limited.

8. *Hand-shaking. — Moistening fingers When Touching Articles.*—The advice of the Health Commissioner of Chicago to refrain from hand-shaking during an epidemic appears to be sound. The practice of moistening the fingers by the lips when counting bills, or turning pages of library books in public reading rooms, or when wrapping up articles in packages should be avoided. Kissing should, as a matter of course, not be indulged in.

9. *Limit Hours of Work. Early closing.*—Limit the working hours in department stores, also in factories. Prohibit advertised "bargain sales" as being apt to draw large crowds of shoppers. Enforce the early closing of other stores, such as barber shops, shoe-cleaning establishments.

10. *Distribute or Stagger the Traffic.*—Lessen the danger of transmission of disease through the overcrowding of cars. A very excellent measure, designed to distribute traffic during morning and evening rush hours, was introduced in 1919 by the Health Commissioner of New York City. It consisted in arranging for slightly varying hours not only for opening and closing of large stores, factories and offices of large corporations, but also of the theaters and places of amusement. By enforcing this measure the traffic was staggered and the overcrowding of cars on subways, elevated and surface lines efficiently prevented.

NOTE—Incidentally, this measure would prove in large cities at all times the best possible solution of the intricate problem of traffic congestion.

In the smaller communities it would probably be better to discontinue temporarily during the epidemic all trolley service.

11. *Face Masks.*—During the influenza epidemic of 1918-19 one preventive measure was introduced, which was a novelty for the layman, although it had been used before in hospital practice. This was the compulsory wearing, by nurses, physicians, hospital attendants and patients' visitors, of gauze face masks, protecting the mouth and nose. The police of New York City, likewise, had orders to wear face masks, when duty called them to houses in which there were cases of influenza. Barbers, dentists, manicures and street sweepers might also adopt the measure. On the other hand, the obligatory wearing of masks by the entire population, as in San Francisco and other places, did not produce the expected results.

Face masks, to be a true protection, should be both properly made and rightly put on. There is, obviously, danger in using them promiscuously. Frequent ster-

ilizing by boiling is a necessary condition. The general use is not only impracticable, but it is a decidedly insanitary measure.*

B. PUBLIC CONVEYANCES.

12. *Cleaning and Disinfecting of Cars.*—The cars of all transportation lines, whether surface, subway or elevated cars, should be cleaned and disinfected every night, for they may accumulate pathogenic germs. Public coaches and cabs for hire should be included in this rule. They must be kept scrupulously clean, and should be disinfected when patients have been taken in them to the hospitals.

13. *Keep Car Windows Open.*—Cars of transportation lines should have some windows always open, for better ventilation, weather permitting. The public should be warned to travel in public conveyances as little as possible. Advise persons to walk daily from their homes to the places of work, long distances excepted.

C. PUBLIC GATHERINGS

14. *Limit Size of Public Gatherings.*—Public gatherings may become the direct agencies for the transmission of disease, hence it is advised to limit their size, to prohibit gatherings altogether if unimportant, and to provide plenty of fresh air and sufficient floor space per person in permitting meetings. In Chicago the police force had orders to disperse street corner gatherings.

15. *Lodge Rooms, Fairs, Exhibitions, etc.*—Close up places of assembly, like lodge rooms, also public fairs, exhibitions, and open-air meetings, where speaking or singing takes place. Postpone dates of conventions. Close up pool rooms, saloons dispensing soft drinks, ice cream and soda fountain parlors, because of danger of spread of the disease through the imperfectly washed drinking utensils, which may become infected. The sterilizing of glasses may not prove a sufficient safeguard.

D. PUBLIC BUILDINGS

16. *Schools.*—The question as to the desirability of closing public and private schools when an epidemic of influenza threatens is an important one, but it is also debatable. Able sanitarians, on one side, argue it is better to keep schools open, and to exercise supervision over the pupils by a careful examination on arrival, by either a school nurse, or a medical inspector. They consider the closing of the schools a danger to the children, because these will then congregate in the street, or in halls of tenement houses, which are not under observation.

Others, equally competent, argue that schools should be closed, because the compulsory attendance necessarily increases the close contact between school children. In the case of public schools, urban and rural conditions differ considerably, and at least in the smaller communities, and in country districts the closing of the schools should be favored.

Where in large cities schools are kept open, the daily inspection of the pupils, the practice of "air flushing" of class rooms, and the sending home of pupils who constantly sneeze or cough should be observed. The law against the use of common drinking cups and roller towels in schools should be enforced.

17. *Colleges.*—Colleges and private boarding schools may institute a mild quarantine against the outer world during an epidemic.

18. *Theaters and Moving Picture Shows.*—Some opinions notwithstanding, I hold that performances in theaters should be stopped, and moving picture shows closed, for the suggestion of keeping attending persons under "close observation," and to "eject careless coughers," seems to be utterly impracticable.

19. *Other Places of Amusement.*—Dance halls, skating rinks, bowling alleys and billiard parlors should be closed because of danger of crowding and too close personal contact. Lectures, concerts, banquets, conventions, and athletic meetings should be very much restricted.

20. *Churches.*—While the suggestion to close up churches during an epidemic may not meet with universal approval, the services can and should be reduced to the lowest possible number. The fonts in Catholic and in Baptist churches should be dispensed with during the epidemic or, if they must be retained, the water should be frequently renewed and sterilized.

21. *Court Houses.*—While the business of courts should be interfered with as little as possible, it may become necessary to close up the court rooms.

22. *Railroad Stations.*—The sanitation of railroad stations requires prompt attention, for such buildings form assembly places for numerous travelers, and the history of epidemics points to the fact that the railroad lines form a principal agent concerned in the spread of disease.

Railroad waiting rooms (and those of trolley lines) should be well ventilated, kept clean, and the floors scrubbed and

* The conclusion of experimental observers is that "face masks have not shown a degree of efficiency to warrant their compulsory application for the checking of an epidemic."

sprinkled daily with some disinfecting solution. Floor sweepings should be safely disposed of or burned.

For drinking water, individual paper cups, or else bubble drinking fountains with parabolic stream should be provided. The toilet rooms should be daily looked after, and the plumbing installation kept in a sanitary condition.

23. *Public and Circulating Libraries.*—It is debatable whether in an epidemic it would not be wise to close up at least the circulating departments of public libraries. Books from public and from private circulating libraries may carry and distribute the illness by droplet infection, if returned by persons slightly ill with the disease. The disinfection of the returned books should be considered, but it is not easily put into execution.

24. *Dental Offices, Barbershops, etc.*—It is self-evident that proper attention should be given by the health authorities to such places as dental offices, barbershops, beauty parlors and manicure establishments.

25. *Restaurants, Bakeries, etc. Food Stores.*—Close up any places where food or beverages are handled or sold under unsanitary conditions, or where cooking utensils and table dishes are not kept scrupulously clean.

Door knobs of food stores, such as groceries, bakeries, meat and fish markets and stores, also butter and egg stores, and the like, should be washed daily with a disinfecting solution (suggest use of Hycol, of Merck & Co.).

NOTE—Unsanitary Dish-washing—
In public eating places, hotels and restaurants, and in public institutions two methods of dish-washing are practiced, viz
(a) washing by hand;
(b) washing by machines.
In method (a) dishes are not sterilized, because the temperature of the hot water cannot be higher than the hands can stand (about 115 to 120° F.). Method (b) is far better, as a scalding temperature of the water can be used in the machine. The method is not only more effective, but more economical. According to Lieutenant Col. Cummings' (Berkley, Cal.) investigations in army camps and in civilian institutions, a much smaller number of cases of influenza and pneumonia occurred where dish-washing machines were in use.

The use of paper dishes, spoons, cups, etc., during an epidemic is recommended, as also the destruction of such utensils after meals by burning. If not so destroyed, they should be disinfected.

Food displayed in eating places and bakeries should always be properly protected.

26. *Public and Commercial Laundries.*—Public and steam laundries should have their sanitary condition inspected. Special care should be used in keeping clean and soiled linen separate. Bedding, soiled handkerchiefs, towels and napkins, when received at laundry, should at once be put into boiling water, or into a sterilizing and disinfecting solution.

In some cases it may become advisable to put laundries under municipal control, or to take them over temporarily.

In Calcutta, during a recent influenza epidemic, the health officer advised disinfecting handkerchiefs, towels, etc., in a 1 per cent. solution of Hycol disinfectant.

Ironing the wash is of some value in killing germs.

27. *Stables and Dairies.*—Strict attention should be given to the sanitation of all city stables, and of milk plants, located within the city limits.

As a suitable disinfectant, Lysol, Beta-Lysol, Hycol and Sterilac (Abbott Laboratories, Chicago) are recommended.

28. *Public Bathhouses; Swimming Pools.*—Public swimming pools should be closed up until the end of an epidemic, but the individual rainbaths or showers may be kept open. Provide the attendants with a disinfecting soap, to be distributed to the bathers.

29. *Public Comfort Stations.*—Public comfort stations should be inspected, cleaned daily with particular care and disinfected. The water closet and urinal flushing pulls, as well as handles of flushing valves, should be washed daily with a disinfecting solution.

30. *Lodging Houses.*—Enforce the maintenance of cleanliness in all lodging houses. Have them frequently inspected and the dormitories and toilets disinfected.

E. STREET SANITATION

31. That street dust is a carrier of disease germs is well known. Accordingly, even at ordinary times, street sprinkling should be practised to lay the dust; this is rendered more effective by applying to the surface a treatment with calcium chloride (Dow's Dowflake or Semet-Solvay's chloride) to keep the surface damp. It is claimed that this is more economical than sprinkling with plain water.

During an epidemic streets should be sprinkled with a disinfecting solution in water (Hycol or Beta-Lysol might be used).

Street gutters and catch basins at street intersections should be carefully examined, swept, flushed and kept scrupulously clean by the force of the city engineering department.

Cities having alleys in the rear of lots should have these well cleaned up, and

all rubbish and organic refuse should be promptly removed.

Property owners and householders should be made to keep sidewalks and footways clean and free from dirt and rubbish, and this should also include the street gutters.

All these measures suggested might prove to be a material help in stamping out the epidemic, for they would prevent pedestrians from carrying street dirt and possibly germs on the shoes into their homes, and into carpets and rugs.

F. DUSTING AND CLEANING

32. School rooms as well as court rooms should, if kept open, be dusted by means of dustless cloths and mops. The use of feather dusters should be prohibited. The sweeping of floors should be done with windows wide open. The use of a disinfecting solution in the mopping up of floors is recommended.

Carpet and rug beating and shaking from the windows or in back yards should be entirely prohibited. Such floor coverings may harbor germs of disease, which would then be scattered broadcast.

Mouthpieces of public telephones should be kept clean, wiped and disinfected, notwithstanding the telephone company may consider such measures to be superfluous. Wherever possible, avoid using a public telephone booth during an epidemic.

G. BANKS AND PAPER MONEY

33. Money, coins as well as bills, continually passing from one person to another, are likely to become the carriers of disease germs. Especially is this suspected of old, worn and dirty paper money. This view, however, is not universally entertained; some disbelievers point to the vast amount of dirty paper bills handled daily by employes of the United States Treasury Department without their becoming infected.

Opposed to this view might be cited the easily verified fact that many banks provide sponges dipped in a germ-killing solution to protect those employees who handle and count money, from infection.

Some years ago, Dr. Parke, of the New York Health Department, found disease-carrying germs on coins; another bacteriologist counted on one bill more than 140,000 bacteria. More recently, bacteriologists of the University of Illinois found old bills laden with germs. If coins carry less germs, this may be due to the metal (copper, nickel) acting as a bactericide.

During an epidemic persons should be warned against the unsanitary practice of holding any money in the mouth, and of licking postage stamps, which also gather bacteria.

During an influenza epidemic, banks should make an effort to issue only clean and new paper money. The writer suggested this in 1919 to the Surgeon-General of the United States Public Health Service. Unfortunately, at that time there was a shortage of paper, and he was told that the United States Treasury Department was unable to comply with the suggestion.

FEATURES OF SEWAGE DISPOSAL PLANT AT RANDOLPH, NEB.

By Keyes C. Gaynor, Consulting Engineer, 525 Trimble Bldg., Sioux City, Iowa.

The small towns, that is, communities from 500 to 2,000 inhabitants, in the middle west often have problems in sewage disposal that are in some ways more difficult to solve than the sewage disposal problems in large cities.

In the first place, these towns are prairie towns and the location for the town was chosen because it happened to be so many miles from some place else and made a convenient place for a railway station. Therefore, the town is often devoid of any water course within the immediate vicinity. Sometimes there is not a stream within several miles. In many other places the country is very flat and it is necessary to resort to pumping to get rid of the sewage at all.

Another difficulty in designing a plant for a small town is that it has to be self-operating. They are usually turned over to the Town Marshal or Street Commissioner to look after, and the average Street Commissioner in a small town has many other things to do and so the sewage disposal plant usually comes in for very scant attention.

These small communities are further handicapped by the fact that they have not sufficient finances to carry on the work, or if they have sufficient finances they do not want to use them for the purpose of sewage disposal.

Although the construction of a sewerage system and a sewage disposal plant is one of the most necessary improvements in these communities, on account of the fact that so many of the people use wells in their yards for their drinking water, I have found that a city council has more difficulty in carrying through an improvement of this kind than any other public improvement which they might under-

take. Street lights and paving, on account of their visibility, are much easier for a city council to install.

The Problem

An illustration of the problems met with in sewage disposal in small towns is the problem of the town of Randolph, in northeastern Nebraska. Randolph is a town of about 1,200 people. A part of this town is situated in the valley of a small creek, which in normal times is 1 ft. deep and 3 ft. wide. It was just barely possible to drain a considerable part of the town, which is built in the valley, into this creek. However, on account of the smallness of the creek, it was inadvisable to empty the sewage directly into it, and on account of floods in the spring time it was rather difficult to put in a disposal plant, including filters near the creek so that the flood waters in the spring would not overflow into the plant.

Furthermore, when this job came to me the town had already voted bonds for the work and the bond issue was for only $6,000 and the council felt that it would be necessary to build this disposal plant so that it would not cost to exceed the amount of the bond issue.

Elements of the Plant

The plant at Randolph consists of a pump cistern or sump into which the sewage flows from the town. From the sump the sewage is pumped into an Imhoff tank and from the Imhoff tank flows into an accumulation chamber, from which it flows onto a rock filter.

The distinctive features of this plant are—first, filters, settling tank, sludge bed and pump sump are all raised up high enough to prevent the overflow of flood waters from the creek in the spring. Another feature in which this plant differs from other plants is that the whole plant is periodical in its operation and there are no siphons. The sewage accumulates in the sump and an automatic switch operated by a float in the sump starts the motor which operates the pump when the sewage rises to the elevation of the inlet pipe.

The raw sewage then starts to flow into the settling basin at one end, and the settled sewage, on account of increased head, starts to flow out at the other end.

VIEW OF SEWAGE TREATMENT PLANT AT RANDOLPH, NEBRASKA.
Pump Sump on Left, Settling Tank in Center and Sprinkling Filter Bed on the Right. A Sludge Bed Lies Directly Back of the Settling Tank.

The size of the pump pit and the size of the accumulation chamber at the discharge end of the tank has been so arranged that when the pump starts the accumulation chamber is empty and there is nothing flowing onto the filter beds.

The rate of pumping is also arranged so the pump will pump twice as much sewage as the nozzles will discharge so that when the pump starts the sewage begins to flow into the accumulation chamber and onto the filter beds, because the pump is pumping twice as fast as the nozzles can discharge the sewage. The sewage accumulates in the accumulation

chamber and builds up a head of about 8 ft. on the nozzles. On account of the balance of sizes of sump, accumulation chamber and nozzle capacity, the sump will be empty at about the time the maximum head occurs in the accumulation chamber, and, of course, when the sump is empty the pump automatically stops, and the head on the nozzles again falls to zero. In this way a variable head is obtained at the nozzles, thus giving a complete distribution of the sewage on the filters.

I have no information as to the exact percentage of purification in this plant, but I do know that the effluent from the filter bed is clear and has no odor and no taste and there has been no complaint from the farmers living along the creek since the plant was put in operation.

OHIO BOULEVARD EXTENSION AT TERRE HAUTE, INDIANA

By George J. Stoner, of Shourds-Stoner Co. Inc., Architects and Engineers, Chicago,, Ill. and Terre Haute, Ind.

The City of Terre Haute, Ind., this year is securing a valuable addition to its park and boulevard system by the construction of an extension of Ohio Boulevard, one of the pioneer drives of the city from 25th Street Eastward one mile to Fruitridge Avenue, the Western boundary of Deming Park.

This was made possible by the splendid gift of Mr. Demas Deming, pioneer banker and realtor of the city, who but recently passed away just as the actual work of construction on this, his last living beneficence to his city was being started.

Last year Mr. Deming offered to the Park Board of Terre Haute a beautiful rolling site of about 155 acres situated on the east bluffs of the Wabash river, just beyond the present city limits for a sum of $155,000, Mr. Deming agreeing to expend this money as follows: One Hundred Thousand Dollars to be given as an endowment to Rose Polytechnic Institute, a technical college of high standing which institution is rebuilding at the present time on a new site several miles east of Terre Haute, and the remaining Fifty-five Thousand Dollars on the Extension of Ohio Boulevard for a distance of one mile to the entrance of the new Deming Park. The Park Board at once accepted this munificent offer and the firm of Engineers of which the writer is a member were commissioned to prepare plans and specifications for the grading and opening of this boulevard and for its improvement with gravel pavement, concrete sidewalks, curb and gutters.

When completed this promises to be one of the most handsome drives of the State. It will be 195 feet in width from property line to property line with two drives each 30 ft. in width and a center parkway 80 ft. in width. Sidewalks 6 ft. wide are set out from each property line a distance of 5 ft. to allow sewer connections later without any cutting of walks or roadways. A tree strip 14 ft. in width, gently sloping to the curb, offers ample space for the growth of trees without danger of the heaving and breakage of curb and sidewalks from roots, which is found so often.

The center parkway is to be 80 ft. in width allowing two rows of trees and space for flowers, shrubs and bushes. It is to be graded to an elevation of 1 ft. above curb line at the center, sloping uniformly at each side. At intersecting streets the curb is curved using a 25 ft. radius and this with the street width of from 60 to 65 ft., gives a delightfully wide expanse for traffic.

The territory traversed is practically all high of a sandy loam with a splendid grade of clean gravel lying from 3 to 8 ft. below the surface. The proximity of the gravel, of course, allows the improvements to be made at a much lower cost than in ordinary conditions. The grades range from a minimum of three-tenths per cent to a maximum of two and one-half per cent on the hill at the western extremity. They are computed in so far as possible so that the lots on both sides will be from 6 ins. to 2½ ft. above the sidewalks without any additional grading, the total yardage being for cut 27,000 cu. yds., and for fill, 36,000 cu. yds.

The drainage of the sub-grade is naturally perfect, due to the nature of the soil and the grades, excepting in one place. In this place a low, flat, swampy piece of ground extends for about one quarter mile on each side of the boulevard with scarcely any difference of elevation. The subgrade drainage in this stretch of about 400 ft. is being taken care of by intercepting ditches filled with coarse gravel.

The city sewer system does not as yet extend to this territory and as Terre Haute is now in the situation where it finds itself confronted with the necessity of a complete rehabilitation and extension of its trunk and belt sewers in a very few years, the problems encountered in a design of this boulevard extension

was to provide proper surface drainage for the first 2 or 3 years and also to provide for connection at a minimum cost to the municipal sewerage system when built. Consequently cast iron curb and gutter type inlets are being installed at the proper places at the present time and may be connected up at any future time to the tearing up of any concrete work or without stopping traffic on the thoroughfare.

The present or old part of Ohio Boulevard extends from the heart of the business district through some of the highest class resident districts of the city, districts which are protected by all possible restrictions so as to provide desirability as a home district. The extension besides providing a boulevard to the new Deming Park, also opens up 16 blocks of high grade residence property and passes within 2 blocks of Edge Wood Grove, another high-class residence suburban district and the old County Fair Grounds recently converted to a city park and a place where the proposed municipal stadium for all public sports, scholastic, amateur and professional are to be held. It will provide an automobile traffic entrance through Deming Park and along Ohio Boulevard to the heart of Terre Haute from the National Road, a highway which at the close of 1922 will probably be entirely paved from Columbus, Ohio to St. Louis, Mo., and over which thousands of auto tourists annually travel, very similar to the entrance from the south to Chicago through Jackson Park, the Midway, Washington Park and Michigan Boulevard, and marks the real beginning of Terre Hautes' Park and Boulevard Developement.

OILING ROADS IN JACKSON COUNTY, MISSOURI

By Leo. E. Kochler, County Surveyor and Highway Engineer of Jackson County Court House, Kansas City, Mo.

Road oils in the past have been used to great advantage for the laying of dust, but experience has taught us that good road oils may not only be used as a dust preventive, but may also be used as a protective cover which will prevent disintegration of the roads, from fast traveling vehicles and also from weather conditions.

In Jackson County we have a chain of some 250 miles or more of water-bound macadam roads which constitute the main arteries of our system and from them radiate the by-ways, or lesser traveled roads. Experience has taught us that the use of even the best of road oils is not advisable on thees macadam highways, and it is our opinion that a bituminous binder in the form of a mat coat is preferable, in face of the fact that the initial cost is greater; therefore, I will eliminate the above mentioned rock roads from my remarks and proceed with the oiling of dirt roads.

Oiling Confined to Dirt Roads

The use of oil on our dirt roads is saving the farmer many times their cost in transporting his products to market, to say nothing of the pleasure of driving over good roads. It encourages the farmer to trim up and otherwise improve his farm—adds to the beauty of the country and to the value of the land.

In Jackson County we have been using oil on dirt roads for several years, with more or less success; as we have studied and experimented we find a great and varied difference in road oils. The first oil, "I am reliably informed," in use here was from 24 to 30 Baume gravity, no mention of asphaltic contents being made. That oil was beneficial as it laid the dust and somewhat shed the water, but being of a light volatile substance it soon evaporated and it was found that the greatest good from that class of oil was obtained by saturating the road in the late fall and this did help to keep the farmer out of the mud during the winter.

Three Essentials to Success

Later experiences have demonstrated to us, that three things are absolutely necessary for the construction of a good oiled dirt road:

1st. Road must be put in proper condition to be oiled.

2nd. The proper kind of road oil must be used.

3rd. Oil must be applied properly and at the proper time.

Preparation of the Road

In discussing requirement No. 1, will say that my greatest trouble in the shaping of a road is with inexperienced help as road builders. We are blessed in this county by an antiquated system of road overseers appointed by the County Court; very frequently not for their knowledge of road building, but for the reason that they are good vote getters, and have little or no interest in good roads. These esteemed gentlemen, of whom I inherited 59, had previously been instructed that the crowning of the road was the most important factor in the shaping of it, and

they proceeded to shape the road like a hip. roof, thereby causing all the travel to go to the center, straddling the ridge so as to not skid into the ditch, which they invariably did when it became necessary to pass someone on the road.

The old saying, "It is hard to teach an old dog new tricks," was true in our case, and inspite of all we could do or say, many of our oiled dirt roads are overcrowned, which causes a dangerous condition in slippery weather.

Our idea of the proper shaping of a dirt road for the receiving of oil is as follows:

The road must be thoroughly ditched and all loose material removed from the roadway to be oiled. Always grade the roadway from the center, pushing the loose material to the outside quarters; here is where a good blade machine man is to be appreciated, as a poor man can do more damage with a blad in one day than can be corrected in several days. The surface of the road should be as solid and free from loose earth as it is possible to make it and should be crowned only enough to cause the water to flow to the ditches, and in this connection will say that it is much better to have the road too flat than over crowned, as on a flat surface the travel is more evenly distributed over the entire surface thereby causing longer life to the road and more safety to travel. Most roads in this section have a longitudinal grade which will take care of the drainage with a very slight crown. A draw always working from the center towards the side of the road should be used after grading is finished.

Proper Kind of Oil

It is very essential that oil for dirt roads should be as near non-volatile as possible, should contain not less than 60 to 70 per cent asphalt and as great a percentage of saturation as possible. The method of refining has much to do with the saturation, volatilization and quality; therefore, we deem it highly essential that a chemical analysis of the oil to be used be made before it is applied, as many of the oils offered are nothing more or less than fuel oil, which will not give satisfactory results.

Application of Oil

This also is very important and it is here that the man in charge of an oiling crew is of great importance, as it is his judging that will determine the amount to be applied and if the road is in shape to receive the oil, and if weather conditions are such that oil should be applied.

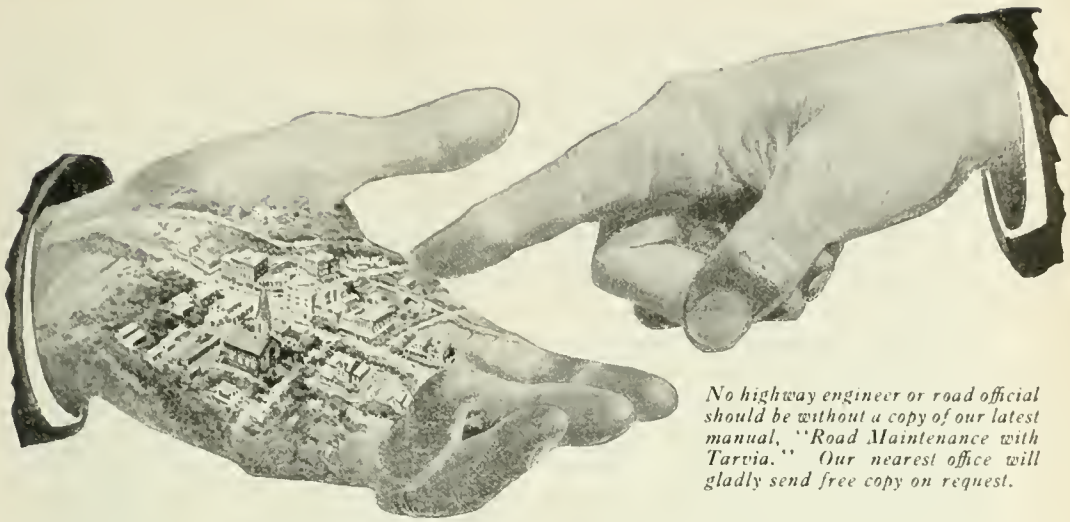
The oil may be applied by either the pressure or gravity feed system. We have adopted the latter on dirt roads on account of the excessive weight of the former, as we found that many of our small bridges and culverts would not carry the weight.

The oiling of hard surfaced roads, we believe, can be done much better by the use of the pressure system as it sprays the oil on much more evenly than can be done by gravity, but on dirt road this is not essential.

One theory of road maintenance is to keep the water out of the subgrade; that theory holds good here. Therefore, a sufficient amount of oil should be applied to form a cushion sufficient for use as a wearing surface, and to seal the surface of the road, thereby making it as nearly waterproof as possible, the exact amount to be applied can be ascertained only by the conditions found on the ground but for general purposes, we should say ½ gal. more or less, per sq. yd. of surface is necessary for the application of one coat. If more than one application is desired, a lighter oil, say one containing 40 to 50 per cent asphalt can be used first and when thoroughly set a second application of oil of 60 to 70 per cent asphaltum should be used; our experience has been that one coat in the spring and another one in the late fall produces the best results as it gives additional strength to the road for the hard and damaging traffic of the winter.

Thus, we believe, with a little care the foregoing procedure will produce a good and inexpensive road that will be smooth, dustless, noiseless and with sufficient rigidity to withstand a heavy rural traffic, the maintenance being very low compared to most hard-surfaced roads.

Missouri is about to enter into a road-building campaign through its newly appointed Commission which will present to each of the 114 counties new and perplexing problems in regard to roads. For a county adjoining or containing (as Jackson does) one of the large cities of the State, it must greatly multiply the number of its roads as they near the city to handle traffic which will naturally flow in from such a far-reaching and elaborate system as is projected by this State. Therefore, Jackson County, with her 250 to 300 miles of rock roads, from 16 to 18 ft. wide, will find herself confronted not only with the problem of building and maintenance of the higher type of roads,



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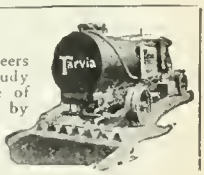

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but the opening, construction and maintaining of many miles of new roads to accommodate the additional traffic; that will be in addition to approximately 750 miles or dirt roads now in use here, the upkeep of which brings us to the subject here—oiling roads.

In closing we wish to submit a copy of that portion of our yearly report pertaining to oiled roads which was submitted to the Jackson County Court on January 2, 1922.

Road Oiling Department

In the year 1921, there were 237 miles of dirt roads oiled once, 47.5 miles of dirt roads that were oiled twice, 151 miles of rock roads that were oiled once, and 21.5 miles of rock roads oiled twice, making a total mileage of roads oiled of 526. There were 1,679,306 gals. of road oil used at a cost of 6¼ cts. or $104,956.63. The cost of placing of the above given amount of oil was $43,113.70, or approximately 2½ cts. per gal.

There was an average of 3,200 gals. of oil used per mile, the cost of which was approximately $200 per mile, the application cost for which was approximately $81 per mile, making a total of $281 per mile. The total cost of road oiling was $148,070.33.

This paper by Mr. Koehler was presented at the annual convention of the Highway Engineers' Association of Missouri, held in Kansas City in January.

ATLANTA ADOPTS ZONING

Atlanta adopted a zoning ordinance April 10, 1922, by a nearly unanimous vote of the Council. The ordinance divides the city into dwelling house, apartment house, business and industrial districts. Three classes of height districts are established with limits of 50 ft., 100 ft. and 150 ft., respectively. Building line, side yard and rear yard requirements are established for all buildings in the residence districts. Lot area requirements are based on the number of housekeeping units for which the residence building is arranged; 5,000 sq. ft. of lot area per family is required for much of the dwelling house area and 2,500 sq. ft. of lot area per family for the area suited to double or two-family house development. In most of the apartment house areas only 625 sq. ft. per family is required, while in the limited hotel and elevator apartment sections there is no minimum lot area requirement, though side, rear and front yards are required.

The zoning plan and ordinance was prepared for the Atlanta Plan Commission by Robert Whitten, City Planner, 4614 Prospect Ave., Cleveland, Ohio. The initial indifference or opposition of the public was overcome by an intensive educational campaign in which newspaper articles, editorials and cartoons played an important part. Five thousand copies of a tentative zoning map and of an attractive illustrated pamphlet describing the proposed zoning and giving the reasons why zoning is necessary, were distributed. Work on the zoning was started by Mr. Whitten in May, 1921, and the zoning ordinance became effective in April, 1922, a little less than a year from the time the work started. Atlanta maintains its reputation for progressiveness by being the first Southern city to adopt a comprehensive zoning plan.

SELECTING TREES FOR CITY STREETS

Oaks are considered by the United States Department of Agriculture to be the best trees for street planting. It is probable that oaks have not been more widely planted because of the prevalent belief that they are slow growers, and because in the North they are rather difficult to transplant. A white oak, however, which is one of the slow-growing varieties, will reach the same height as a sugar maple in the same period of time, and maples have been used much more widely than oaks for street ornamentation, despite many unsatisfactory characteristics.

A new Farmers' Bulletin, No. 1208, "Trees for Town and City Streets," by F. L. Mulford, horticulturist, issued by the United States Department of Agriculture, describes in detail the various oaks for street use in different regions, as well as about 100 other trees or varieties. Elms are given second place in desirability for city streets, and sycamores third. Maples are considered less desirable than has been generally supposed. Except the Lombardy poplar, most varieties of poplar are not recommended.

The bulletin, which is available upon application to the United States Department of Agriculture, contains a regional map of the United States and indicates which trees flourish best under the climatic conditions of each region.

WATER WORKS SECTION

PUMPING PLANT OF NEW HIGH PRESSURE FIRE SYSTEM AT BUFFALO, NEW YORK

By W. B. Powell, Treasurer, Industrial Planning Corporation, Consulting Engineers, 80 West Genesee St., Buffalo, N. Y.

For a number of years past, the business district of the City of Buffalo has been protected by a high pressure system of water mains separate from the regular city supply, with special hydrants placed at important points throughout the district. This high pressure system is arranged so that the fire boats in the harbor can attach the discharge from their pumps to the ends of the mains at two points on the water front, thereby furnishing large volumes of water at about 140 lbs. pressure entirely independent of the supply provided from the pumping station.

The Old High Pressure System.

The mains for this service run north from the Buffalo River through Washington and Pearl streets to Huron, paralleling Main street on both sides and reaching within a block all of the high business and office buildings in the congested center of the city. Within this area is comprehended the largest building values and consequently it is also within these limits that the greatest street traffic congestion is to be found. Naturally the passage of the fire-fighting apparatus is considerably retarded through streets crowded with traffic and in addition the low pressure of the regular water system is inadequate to cope with a fire in the high office buildings in this district, so that the present high pressure system has been of great protective value.

Nevertheless, its use necessitates the stationing of one or two fireboats at fixed points, thereby withdrawing them from service as protectors of the harbor and water front property, and it has been recognized that this might prove a serious hazard in the event of a large conflagration. Furthermore, even at their best performance, the boats cannot adequately supply water for more than about 10 nozzles, so that the city authorities decided to extend and improve the high pressure system by installing a separate source of supply capable of much larger emergency service.

Fire Chief Murphy was principally responsible for this decision, and he has co-operated with Water Commissioner Andrews, under whose direction the plans have been developed and the work is now being installed. The design of the details of the pumping plant within the station has been done in detail by a firm of local engineers, the Industrial Planning Corporation, who have had a wide range of experience in special pumping problems.

New High Pressure Main

A new 20-in. cast-iron pipe main has been installed from the city pumping station at the foot of Porter Avenue through Jersey and Front Streets, to Georgia Street, where it is divided into two 16-in. mains, one branch continuing down Front Street through the Terrace to Pearl Street, where it joins the existing line in that street, and the other branch passing through Georgia and Huron Streets to Washington Street, connecting with the upper ends of both of the present lines in Pearl and Washington Streets. The old line in Washington Street was not adequate to carry the proposed 300 lbs. pressure of the new system and has been replaced with new pipe and a cross connection has been made at Exchange Street between the two principal mains so as to loop the entire system around the heart of the business district of the city.

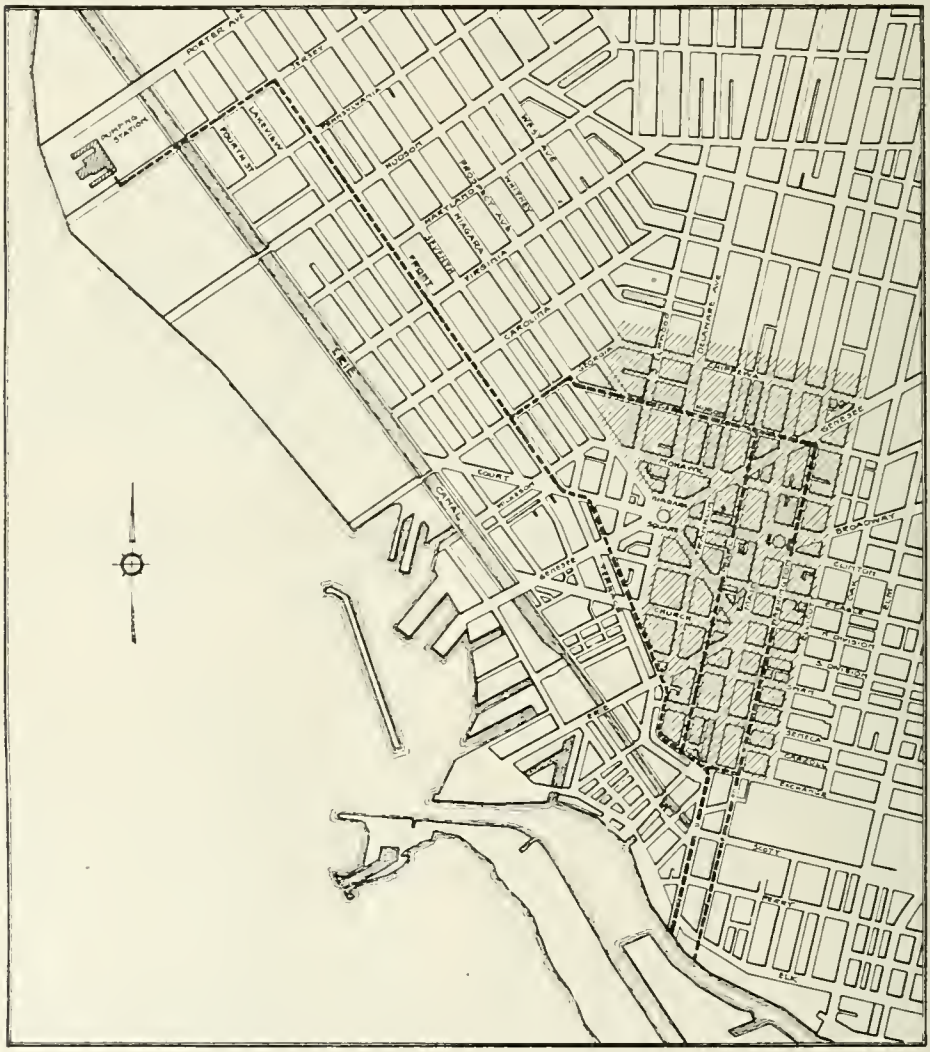
This district (shaded on map) may be said to be bounded roughly by the Terrace and Elmwood Avenue on the south and west, Chippewa Street on the north and Ellicott Street on the east, with the largest values centered along Main Street, so that this double loop system will provide adequate protective water supply from two directions to any point in the district, while it will also retain the present fireboat supply connections at the south end of the loop in the unlikely event of failure on the part of the new pumping station feeding the loop from the north. Incidentally, the future growth of the business section of the city is safeguarded because the trend of development is northward between Delaware Avenue

and Main Street, and still further the large area of industrial activity located along the water front and extending along the line of the old canal will now be protected from the land side by the main through Front Street and Terrace as well as by the fire boats in the harbor.

The Pumping Plant

The plant in the pumping station has been designed with the greatest care, having in mind above all other considerations instantaneous starting and dependability to deliver full capacity at all times, even though such service may be required only at very infrequent times. The present pumping station is already equipped with ample boiler plant so that no additional steam power is required, and consequently the question of economy of operation, important as it always is, was in this case considered as of secondary importance. The whole effort was centered on getting the full capacity of the plant into action at top pressure upon an instant's notice, and then to maintain its performance at that rate for an indefinite time delivering as large a volume of water as possible per pound of steam consumed.

The primary units of the plant will be three turbine-driven centrifugal pumps, each of 3000 gals. per min. capacity with a delivery pressure of 300 lbs. These pumps are designed so that they can



MAP SHOWING NEW HIGH PRESSURE FIRE SERVICE LINE FOR THE CITY OF BUFFALO, NEW YORK.

deliver their full capacity within 90 seconds after the sounding of the alarm at the station.

The Steam Turbines

The steam turbines are being furnished by the Terry Steam Turbine Company. They are rated at 750 H. P. each, using steam from the present station boilers at 225 lbs. pressure with 60 degs. superheat. They operate non-condensing, with a single rotor cut out of a solid block of metal and their normal speed is 3,170 R. P. M.

While every possible precaution is being taken to eliminate condensation in the steam lines, the necessity of being able to start up to full capacity instantly is so vital that the most rugged construction of rotor was selected, as well as a type of machine which is capable of passing a slug of water from the steam supply riser without any interruption or slowing of the apparatus.

The expense of condensing equipment was not considered to be justified for economy of operation in the face of the greater time required to start such apparatus and the greater complexity of mechanism which would tend to increase the hazard of a breakdown.

The Pumps

The pumps are made by the Manistee Iron Works and are 4-stage with solid bronze rotors running at 1,500 R. P. M. The speed reduction is accomplished by a set of herring-bone spur gears running in an oil bath, which forms part of a circulating and cooling oil system providing positive lubrication for all parts of the set. The manufacturers have joined in guaranteeing that the combined unit will deliver 8 gals. of water under the specified conditions for each pound of steam consumed.

A 30-in. suction main from the river, protected with a foot valve, furnishes supply to the 10-in. pump connections and the 10-in. delivery lines are brought into the 20-in. main header at an angle of 45 degs. so as to reduce line losses to a minimum. Any single pump or combination of pumps may be operated, and the entire system is kept full of water from the regular city supply at a pressure of about 40 lbs. so that immediately upon receiving an alarm it will only be necessary to open the steam throttle wide to bring a unit up to speed. Suitable check valves make the system automatic.

The construction work on the pipe lines in the down-town loop is already completed, and the installation of the pumping equipment will be accomplished during the coming summer.

Acceptance Tests

The specifications provide that full working tests shall be made before the equipment will be accepted, these tests to include the operation of each unit under full working conditions for a period of 24 hours, at least one of them for 48 hours, and the combined operation of all the units for total capacity for at least one hour. It is anticipated that most fires can be handled by only one pump, and that only the largest conflagrations will require the operation of all three pumps together.

FIFTH OMAHA RESERVOIR EMBODIES NEW PRINCIPLES IN DESIGN

The organization which operates Omaha's water plant has placed in operation the fifth of a series of water reservoirs built on a design which was untried, insofar as they knew, at the time the first was constructed nearly eight years ago. Fifty-nine million gallons of water are now stored in concrete lined basins of this design, and the condition of the first is such that the greatest confidence marks the inauguration into service of the fifth. A design embodying new principles, a constructing unit organized to build with painstaking attention to detail and the

CONSTRUCTION VIEW OF THE FIFTH OMAHA WATER WORKS RESERVOIR.

unswerving fidelity to the ideal of absolute perfection of each small unit of the aggregate, has produced a type of reservoir lining that, under the conditions imposed by the local topography and sub-

soil formations, has met the desires of the designers.

Lining Like Concrete "Blanket"

The lining can best be described as a "concrete blanket," since it is not designed to be inflexible. The bearing soil is excellent, but it was expected that there would be local settlement, and a lining was constructed with a certain degree of flexibility to conform to these movements.

Six inches of re-inforced concrete is placed on the carefully compacted soil base in such a way as to get the nearest possible approach to a perfect bond between successive courses, the steel re-

VIEW OF THE 10-S SMITH TILTING MIXER USED ON CONSTRUCTION OF THE NEW WATER RESERVOIR AT OMAHA, NEB. A POWER LOADER AND EXTENDED TRACK MAKES IT POSSIBLE TO TAKE AGGREGATE FROM LOWER LEVEL TO THE HOPPER ABOVE.

inforcing is accurately spaced at the determined height above the bottom of the slab, and the aggregates are mixed in a plant designed to produce a product of as near uniform consistency and composition as is possible.

The aggregate used in Basin No. 7, constructed in the fall of 1921, consisted of a so-called Sand-Gravel, which might be quite as properly called a coarse sand, since a very small percentage is retained on a No. 4 sieve. The proportion was one part Portland Cement to three parts sand-gravel, and to this was added soap and alum as an integral waterproofing. The steel mat consisted of ½ in. square deformed bars spaced to give four-tenths of one percent of the area of the concrete, both transversely and longitudinally, and was rigidly tied and held so as to have its lower edge 1 in. above the bottom of the concrete.

Concentric Courses

Concrete was placed on concentric courses around the basin, the width of the course being limited by the height on the slope which could be placed without slipping. The edges of the previously poured course were roughened where necessary, all was treated with dilute hydrochloric acid and carefully washed. Finishing was done with wood floats and steel trowels.

The mixing plant was a permanent one, consisting of a No. 10-S Smith Tilting Mixer driven by electric motor, and the necessary receiving hopper and apparatus for mixing and applying the waterproofing. The mixer was placed on a frame at a sufficient height above the ground to allow two-wheeled buggies to be charged from the hopper and the elevating loading skip was served by one-horse dump carts. The Smith loader with extended track takes the aggregate from the lower level to the hopper above. A small boiler was necessary for dissolving the waterproofing soap and alum, and electrically driven pumps handled the prepared tempering water to the gaging tanks.

200,000,000 Gal. Capacity

All aggregates were carefully measured, including the sand-gravel, the cement, water and soap. The time of mixing was kept uniform and of sufficient amount, and every precaution taken to insure the highest possible quality of concrete.

Basin No. 7 is 303 ft. by 385 ft., and the depth from top of parapet to bottom of mud compartment is 36.5 ft. Its capacity is 20,000,000 gals., and will serve as a clear water basin in the present sedimentation system of purification, but is so located as to be used for the effluent from a filter plant. Mr. Knouse, engineer of the Water Board of Omaha, was in charge of this work.

REARRANGING THE PARK RIDGE, ILL., PUMPING STATION

By W. T. McClenehan, Assistant Engineer with Pearse, Greeley & Hansen, 39 W. Adams St., Chicago, Ill

Anyone at all familiar with the water works game knows that a pumping sta-

tion is always being remodeled, always changed. Pumps wear out; they become antiquated because of improvements in pump manufacture and they are supplemented by new and larger pumps added because of the city's increased population.

In spite of this constant change, men in charge of pumping stations frequently do not realize the value of a well-defined plan or program for making future additions to their pumping stations. They have adopted a "sufficient unto the day is the evil thereof" policy and improvements are made because of some immediate necessity forced suddenly upon them. As a result of this indifference many pumping stations have become a patchwork of machinery, pipe and buildings, often poorly related, one part to another, and sometimes curiosities wonderful to behold. The administration which adopts such a policy is not always to be blamed for its indifference for the men that make it up may be ignorant of the real engineering requirements. In such cases it becomes the duty of the engineer to make the administration see the real value of a well thought out plan for making additions.

In addition to adopting a plan for making improvements a city should occasionally take stock of the improvements it already possesses in the way of machinery, pipe, buildings, etc., to see whether they cannot be better arranged for pumping purposes. A study of this kind is especially advantageous where new equipment or new pumps are about to be added. The saving in friction and power may be considerable and the re-arrangement generally makes for a better looking, more convenient station.

The mayor and city council of Park Ridge, Ill., fully realized that their pumping station had been outgrown and that it needed remodeling. They therefore employed the firm of Pearse, Greeley & Hansen last December to study the future requirements of the city and to make plans for improvements needed in the pumping station.

Originally the pumping station consisted of a well drilled into the Pottsdam sandstone, an electrically driven deep-well pump and a 6-in. main laid in the pump room floor to a standpipe built just west of the pump house. Off this water main in the pump room floor were taken two 6-in. connections to the city, one leading south to a line in Center Street and one north to a line in Park Avenue. Valves were placed on these three lines, which were exposed in the pump room. No meter was included. It will be seen from this description that the arrangement of the original pumping station was not so bad at the time it was built. However, it was not long before changes were made which upset the arrangement. The standpipe was replaced by an elevated tank, involving two connections to the mains in the pump house and providing a new connection to the line in Center Street. A new well was drilled in a southwest room built under the sidewalk on Center Street and connections made thereto. A 12-in. line was laid from the Chicago water system at the city limits and three different connections were made to the Park Ridge mains inside the pump house and one outside. About this time the original well was abandoned Recently an air lift system was partly installed in the newer well to supplement the water supply received from Chicago in hot weather when the demand in Park Ridge exceeded the amount of water the City of Chicago was willing to sell.

Two centrifugal pumps were bought and one temporarily installed to boost the pressure when the Chicago pressure is low. The intention was to arrange the pumps to take water from the well reservoir also but this work was never completed.

Such, therefore, was the situation about the plant when we took hold of it last December. There were no less than 11 different pipe connections to various mains inside the pump house and around the elevated tank. Most of the confusion was caused by the natural growth of the plant, but some of it was caused by incompleted construction. Even the pumper did not know where all the lines were. In fact, he scarcely knew the function of all the valves he had to handle.

Our first work was accurately to locate all valves, pipe lines, etc., inside and outside the building and to obtain the charactertistics of the pumps, motors and air compressors. From a study of the city's past increase in population and from a be about 6,000 and that the maximum 12-hour consumption would be about 1.5 mil- over a period of several months, we estimated that by 1935 the population would record of water purchases from Chicago lion gallons per 24 hours| For short periods during the 12 hours this rate would be exceeded but the tank we figured would supply the excess consumption. In addition it was estimated that the probable fire demand in 1935 would be about 3 million gallons per 24 hours.

The two centrifugal pumps had a com-

bined capacity of around 2 million gallons, so that it seemed likely that another pump would be required in the near future. Pipe lines were based on the requirements estimated for 1950 because of the greater life of the pipe. This rate was about 5 million gals. per 24 hours.

The problem of a layout was somewhat complicated by the awkward shape of the building, which was shaped like a flat-iron, with but few parallel or right-angle walls. The layout selected, places a 12-in. suction line along the south wall on the floor, connecting at one end to the Chicago main outside the building and extending into the well reservoir at the other end. Each end of this line will be valved for drawing water from either source of supply. Above the suction line will be placed the discharge header with a valved cross connection between it and the suction line. A Venturi meter is to be installed in the discharge line inside the pump house but leaving room for the cutting in of another pump when that pump becomes necessary. The water will be discharged toward the west toward the elevated tank, although the city is largely to the east of the pumps. The reason for this is that existing piping could be utilized to better advantage and that all water could be metered. Besides that, the largest flow at most times is likely to be into the tank.

Some re-arrangement of the outside piping was found necessary. The most important change is the addition of about 90 ft. of 8-in. pipe line to be laid to connect to an important point of intersection. A hydraulically operated valve was placed in a pit outside the pump house at the base of the elevated tank. The operating cock of this valve was placed inside the pump house on a post so as to be easily reached by the pumper in case of fire.

The pumps were so arranged that they would work either in parallel or in series, the change being accomplished by opening or closing one valve.

The switchboard is to be placed on a concrete platform at the level of the street above the pipe lines. The board was a part of a former purchase of pumps and motor equipment and is very good indeed. It has provision on it for no voltage and overload release and is made for push button and for automatic operation using a pressure gauge.

We have arranged to place the push button stations on the same post with the cock which operates the hydraulic valve.

The air lift system is being somewhat re-arranged and completed so that the well which has been fitted up with the well head can be used this summer. By this arrangement the engineer can do the following things without leaving the pump room:

1. Draw water from Chicago without pumping.
2. Draw water from Chicago using either or both pumps in parallel or in series.
3. Draw water from the well reservoirs, using either or both pumps in parallel or in series.
4. Operate the hydraulic valve.
5. Operate the air lift system.

Some old piping in the floor of the pump room can be utilized to discharge into the well reservoir whenever the older well is fitted up for use, which will be whenever the present supplies prove inadequate.

The only new machinery bought is a small vacuum pump to prime the centrifugals when it is necessary to pump from the reservoir.

The cost of the entire work is about $6,600, including the building and manhole construction. While this layout is not ideal in every respect, it shows what can be done to an existing pumping station at very small cost, utilizing existing equipment so as to make the whole station more serviceable, more workable and better looking.

The foregoing paper by Mr. McClenehan was presented at the recent meeting of the Illinois Section of the American Water Works Association.

WATER WORKS RECONSTRUCTION AT ROCKFORD, ILL.

By Rodney C. Wilson, Superintendent of Water Department, Rockford, Ill.

For a number of years Rockford has had an inadequate water supply. Sprinkling has been partially eleminated each summer and no effort made to get larger industrial consumers.

In 1910 the city had an investigation, of their water supply, made by Messrs. Mead, Maury and Alvord, their findings being summarized in a very complete and detailed report.

The only thing attempted, to follow out suggestions, has been the installation of two electrically driven unit wells, one in the north end and another in the south-

east end of town, also the laying of a few large mains.

In 1919 a bond issue was authorized and Messrs. Meade & Seastone, of Madison, Wis., retained as consulting engineers, to design and construct the new water works. The question of deep wells or filtered river water was decided in favor of deep wells; the opinion was that it would be foolish to purify water artificially, with an element of human error creeping in, when an abundant supply of pure water could be had by drilling, and at no greater expense.

The question of location was next decided and a location on the west side of the city chosen. The future growth of the city's population, and distribution system, was taken into consideration, as well as the cost of the land.

In designing the new plant the thought throughout has been to plan for the future and have adequate facilities for expanding and enlarging, and not repeat the mistake of former years, of having to relocate and practically abandon the present water works, because of the poor location chosen preventing any possible expansion. This is readily evident when one realizes that the old plant is on the bank of the Rock River, in the heart of the business district, and every pound of coal used has to be hauled by truck or wagons.

New Concrete Reservoir

The construction of the new plant was started in June, 1920, with the building of a 5,000,000-gal. reservoir, of reinforced concrete, and possessing several novel features of design. The floor and the walls of this reservoir are built as one unit and the columns and roof as another unit. One can readily realize that the expansion of the roof, with the sun beating down upon it, would be much greater than the walls, with the reservoir filled with water. This design eliminates the danger of the roof cracking the walls. To permit the movement of the roof on the walls, due to expansion and contraction, a greased, galvanized plate has been inserted on top of the walls.

The Deep Wells

As previously mentioned, the water supply is from deep wells. The drilling of the first well was started in July, 1920, and at the present time we have three wells completed, and the fourth one well under way. The wells, for the first 300 ft., are 14-in. bore and then, to the depth of 1,600 ft., are 12-in. diameter. The wells are cased with 15-in. steel pipe into the rock, to a depth of 110 ft. from the surface, at which point a cement joint is made. This effectively seals off the wells and prevents any ground water from seeping in. There are two underlying water supplies, one—St. Peters—which is at a depth of about 200 ft. and is about 150 ft. thick, the other the Potsdam sandstone, which is beneath the St. Peters and separated from it by the Magnesium limestone. This Magnesium limestone is about 250 ft. thick in this locality. Our wells thus extend into the Potsdam sandstone about 1,000 ft. The capacity of each well is estimated at between 2 and 2½ million gallons per day. These wells are separated from each other about a city block and it is believed that pumping at this rate the level of the water in the wells will not be drawn down over a maximum of about 80 ft. The water now stands in the wells about 30 ft. from the surface.

The Pumping Station and Pumps

The pumping station building itself is an imposing structure, set back from the street about 90 ft., built of Chicago common brick, with raked joints in chocolate-colored mortar, with a little standstone trim. The pump room itself is about 60 x 114 ft., rising 40 ft. above the foundation, this height being necessary to permit the installation of a 10 and a 15-ton Whiting crane. The right half of this building will contain a new 2,500 cu. ft. Laidlaw air compressor and a 1,500 cu. ft. Ingersoll-Rand air compressor. The latter compressor is now in operation at the old plant but will be moved some time this summer. This gives us a duplicate pumping outfit for the deep wells.

In pumping the wells an initial air pressure of about 100 lbs. is carried and the air conveyed through 6 and 8 in. Crane special coated pipe line to the wells. The wells themselves will be equipped with an Indiana air lift, which will force the water up and into a so-called booster chamber and from there into the reservoir, through a 16-in. conduit. The piping is so arranged that any one or all of the wells can be pumped at the same time.

The left half of the building will contain a 15,000,000-gal horizontal cross compound condensing Snow pump and a 10,000,000-gal. pump of similar make. The latter pump is now doing duty at the old pumping station.

The 36-in. discharge, from the reservoir, flows into a suction well, just outside of the pump room. This suction well is 24

ft. in diameter and has a valve chamber outside. The suction to the pumps is 30 ins. The pumps discharge into a 36-in. header connecting with the 24-in. discharge line. This header is arranged to feed the city in two directions and permits the by-pass of either pump. It is our aim to have a Venturi recording meter set in this line, to permit an accurate measurement of the send-out.

The Boiler Room

Adjoining the pump room is the boiler room, which is 62x75 ft., and has an extreme heighth of about 70 ft. This extreme heighth was made necessary by the installation of coal bunkers, which we expect to have installed by the middle of June. These are steel bunkers, suspended on steel columns, and have a capacity of 450 tons of coal; they are divided into four pockets, one of which is for ashes. The coal will be conveyed from the track, at the rear of the building, through a concrete tunnel, and fed to the bunkers by a link-belt. The boiler equipment consists of three 300 H. P. Stirling boilers, equipped with the Jones underfeed automatic Stokers. The boiler feed water is softened by a Graver Corporation water softener, which uses lime and soda ash. The filtered water from this softener goes to a Reliance, open type, feed water heater and from there it is pumped into the boilers.

The plant is designed for efficient operation. The automatic stokers, the overhead bunkers and automatic scales and ash conveyors cut the labor charges in the boiler room to a minimum. The condensing engines, feed water heaters and steam traps, for turning all condensation into the hot well, permits the efficient operation from the steam consumption standpoint.

When completed the cost will be approximately $750,000, which added to the previous investment of the city, in water works and distribution system, makes a total investment for the city of about $2,000,000. This is about $20 per capita, and is, I believe, slightly under the average for cities throughout the United States.

We expect to have the plant tested out in May and it should be pumping and supplying the city with water this summer.

The foregoing paper by Mr. Wilson was presented at the recent annual meeting of the Illinois Section of the American Water Works Association.

GROUND WATER SUPPLIES FROM PRE-GLACIAL VALLEYS

By Willis D. P. Warren, of Holbrook, Warren & Andrew, Consulting and Designing Engineers, Millikin, Bldg., Decatur, Ill.

General

Ground-water supplies are generally found in pre-glacial valleys and it is therefore, of considerable importance to understand the methods of determining the location and boundaries of such valleys. It is the purpose of this article to discuss and emphasize the principles which govern the economical development of shallow ground-water supplies and to point out the relation which deposits furnishing such supplies have to the pre-glacial valleys.

In Illinois, where there are more than 600 cities and villages of less than 2,000 population without a public water supply, and where many of the other cities are in need of additional supplies, it is a matter of the most vital importance that we utilize all the resources which have been so generously provided by nature, and it is with this thought in mind that it is proposed to show the value of water-bearing deposits in the pre-glacial valleys, and the methods of developing same.

Experience of Virden and Girard, Illinois

During the past 5 years ,and to a certain extent during the past 30 years, the cities of Virden and Girard, located in Central Illinois, have endeavored to develop water from wells, and as the experience of these cities is somewhat typical, it may be of interest to point out the ease with which they finally discovered a water supply in a pre-glacial valley, after many years of tests and experiments elsewhere.

Preliminary Investigations Virden and Girard:

Virden has a population of about 5,000, and Girard about 2,500, and as each had spent considerable money at various times in seeking a water supply from wells, it was finally decided last year that our firm should be employed to make surveys and estimates of reservoir sites with a view to the development of a surface supply, suitable for both towns, inasmuch as they are only 2½ miles apart.

At that time Virden had abandoned all hope of a supply from wells and Girard was testing a territory which had shown but slight promise of a well supply during former investigations .

Upon completion of preliminary surveys, plans and estimates of surface sup-

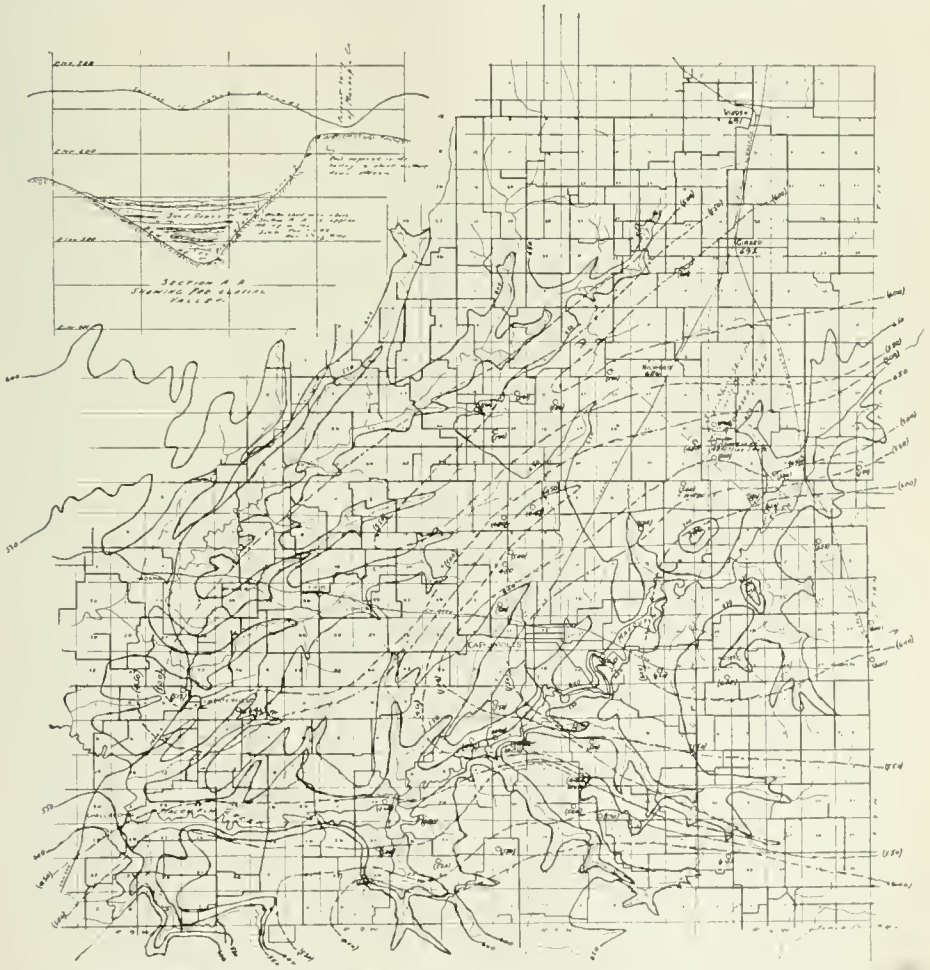
plies, it was seen that unusual costs would be involved due to the lack of a natural reservoir site, and therefore further consideration was again given the possibility of a well supply, even though it might be located at some distance from the city.

As Virden had put down 12 to 15 holes, the majority of them on one 40-acre tract, and had failed to secure a well supply, and as Girard had more recently put down 10 or 12 holes, also with poor results, it was finally decided that consideration would be given a location about five miles south of Girard and nine miles south of Virden, early information regarding this site tending to show a remarkable supply of ground-water available. Accordingly the investigation of a well supply was undertaken in this territory, the final result being the discovery of a pre-glacial valley filled with water-bearing sand and gravel, and fed from a water shed area of approximately 100 sq. miles.

Locating the Pre-Glacial Valley

There are several fundamental principles involved in the development of shallow ground-water supplies, and one of the most important of these was clearly stated by Hubbard and Kiersted in "Water Works Management and Maintenance," as follows: "No more water can be continuously taken out of the ground than goes into it." In other words, the extent of the water shed area which feeds the underground gravel bed is of vital importance.

With this principle in mind we had



OUTLINE MAP OF PORTION OF MACOUPIN COUNTY, ILL., SHOWING SURFACE STREAMS, SURFACE CONTOURS WITH 50 FT. INTERVALS AND SUBSURFACE CONTOURS ON BOTTOM OF GLACIAL DRIFT WITH 50 FT. INTERVALS.

Surface Contours in Solid Lines. Subsurface Contours in Dotted Lines. Circles Indicate Points at Which Borings Were Made to Investigate Subsurface Conditions.

some difficulty in becoming interested in the development of wells at the site suggested, for a glimpse at the map showed only a few square miles of water-shed area, with a prospect therefore of being able to develope a very limited supply.

As the reports of water found were quite positive, however, a conference was held with officials of the Standard Oil Company at Carlinville, Illinois, and substantially the following information secured:

Mr. C. W. Clark, Assistant General Manager, stated that a year or so previously his company had undertaken to put down a modern mine shaft there ,that after going down some distance they encountered unusual quantities of sand and water, and that finally after having pumped for days, and after having spent approximately $200,000 they were absolutely forced to abandon the shaft due to the strong flow of water. Pumping did not lower the level of water over a few feet below the ground surface.

As this shaft was located in a rather flat prairie country it was difficult to account for such a flow. However, as Mr. Clark kindly offered his files showing record of drill holes in that territory ,it was possible to trace the source. In fact the information secured from these files, together with additional records of drillings from the State Geological Survey afforded an opportunity to study the relation of the ground-water to the pre-glacial valley which ordinarily could not have been done except by sinking a number of carefully located test wells.

Sub-Surface Contours

The accompanying plan shows a general outline map of this territory, with streams, surface contours at 50-ft. intervals, and sub-surface contours, or contours on the bottom of the glacial drift, at 50-ft. intervals.

These were located by platting the elevation of the base of the glacial drift as determined by test holes, and the final result shows the pre-glacial valley of Macoupin Creek located north of Carlinville, underlying a flat prairie country, while the modern valley of Macoupin Creek is south of Carlinville, as is clearly shown by the cross-section, and is located at an elevation practically 140 ft. higher than the pre-glacial valley, thus tending to cause the undergrolnd waters of Macoupin Creek to seek the pre-glacial valley.

It appears from a study of the situation presented here, that the glacier in flowing to the south covered over the old valley, and since then the modern creek has gradually cut its way to rock or shale at points south of Carlinville. The presence of unusual amounts of water in the pre-glacial valley to the west of Carlinville was noted by drillers, although all the holes shown were put down in a search for oil .

In the interpretation of the drill records and other data bearing on this development, much credit is due Mr. G. C. Habermeyer of the State Water Survey and Dr. M. M. Leighton, of the State Geological Survey, both of Urbana.

In this connection, Mr. Habermeyer advised in part as follows: "Report of water supply investigations for Virden and Girard, dated February, 1922, is received and read with interest. That looks like an excellent job in tracing out old stream valleys."

Also under date of March 15th, Dr. Leighton advised as follows: "I have gone over the evidence bearing on the question of an old pre-glacial valley in the vicinity south of (Girard) Nilwood. This evidence seems to be good and the existence of sand and gravel at the bottom of this valley, as tested by several wells, and the abundant supply which came from the shaft of the Standard Oil Company, all indicate that this is a favorable place to drill for a water supply."

Advantages of Gathering Ground

In considering the vicinity of the Standard Oil shaft as a location for the development of a ground-water supply the following important facts and advantages should be clearly understood:

1. The percolating water that fills the sand and gravel deposit in the old pre-glacial valley, is supplied from a water-shed area of 100 square miles, an area sufficient to provide for a population of several hundred thousand.

2. Storage of the percolating water depends on the extent of the sand and gravel deposit in the pre-glacial valley, and in this case sufficient test holes have been put down to indicate ample storage.

Probably one-fourth to one-third the volume of sand can be taken as the volume of water available, and from the data shown on accompanying plat it is readily seen that the supply of water here is more than adequate. At some points the sand shows a depth of 100 ft.

3. The longitudinal and transverse slope of the pre-glacial valley is such that maximum velocity of flow of water will be secured, in so far as the quality of sand will allow.

4. The quality of sand is such as to permit the development of water at reasonable cost. In most deposits of this character, the sand varies in coarseness at different points in the valley, and the final location of wells and the type of screens and installation will depend somewhat on the quality of sand available. In the present case the sand is of a quality to permit development of wells at a reasonable cost.

Importance of Studies

In the studies and investigations made over an extended period of years in the vicinity of Virden and Girard by various city councils under different engineers, it may be seen that little thought was paid to the importance of locating the pre-glacial valley. Had a series of holes been put down west of Girard or north of Virden, determining the location of the pre-glacial valley and the water-shed area, much useless expense and delay might have been avoided.

As the situation stands today, there has been so much haphazard drilling through this territory that the people have little heart in any suggestion as to a more careful study near Girard or Virden and, therefore, considering the positive information which we have regarding the supply near the Standard Oil shaft, it is thought that no further expense should be incurred in prespecting elsewhere .

A study of old pre-glacial valleys has shown that the present channels are often quite remote from the old, and this is fully borne out by the situation south of Girard.

A glance at the map will indicate the value of knowledge relative to the pre-glacial valley north of Carlinville, as that city may at some future date require an additional supply of water.

It is desired to point out here that a complete mineral analysis is of course essential before final adoption of any site. However, the point to be made in this discussion is the relation of the pre-glacial valley to well supplies, rather than a comparison of mineral qualities of underground and surface supplies.

The cities of Virden and Girard have not yet proceeded to the construction of a pumping plant at the site of the Standard Oil shaft, but they have secured positive information as to the existence of a remarkable water bearing deposit in their vicinity, information which they have sought for many years, and as a result, they are a step nearer the final solution of their water supply problem.

Comparison With Surface Requirements

It is quite generally understood that in developing a surface supply certain fundamental principles govern, and it is desired again to point out here that certain fundamental principles also govern in the development of a shallow ground-water supply.

Briefly the considerations which govern the development of impounding reservoirs are as follows: 1. Extent of water-shed area. 2. Rainfall. 3. Run-off. 4. Percolation. 5. Storage available.

For the development of a shallow ground-water supply, the fundamental principles which govern are as follows: 1. Extent of water-shed area. 2. Rainfall. 3. Run-off. 4. Percolation: 5. Storage available.

Comparison shows that the fundamental requirements are absolutely the same. And yet how few cities know and apply these principles? How many cities having wells know the area of the water-shed from which they are supplied, and how many have knowledge of the available underground storage?

Hubbard and Kiersted, above referred to, point out the following fundamental considerations which govern:

"No more water can be continuously taken out of the ground than goes into it.

"The yield of the ground-water is dependent upon the character and extent of the catchment area and depth of the saturated water-bearing material.

"The velocity of flow of ground-water depends upon the character of material through which it must pass in gravitating from a higher to a lower level.

"The stability of the ground-water supply depends upon the three considerations above stated as well as upon available ground storage at the point selected for developing the water supply."

Goodell, in his book "Water Works for Small Cities and Towns," also states this principle, as follows:

"The amount of water that may be obtained from deep and shallow wells is so often over-estimated that it is necessary to call attention to the fact that the quantity available depends on the *same* conditions as the amount of surface water, that is, the extent of the catchment area, the rainfall, the proportion of the rainfall entering the ground and the capacity of the basin to hold ground-water."

It may be contended that it is a rather

difficult and expensive matter to determine the water-shed area and the amount of underground storage. Possibly this is true, and yet does not the cost of a water works system require certain expense for investigation, and does not the planning of a works capable of fitting into any future scheme of development require very thorough and careful study? In the development of a surface supply we do not accept a natural reservoir site without knowledge of the water-shed area and the other factors which govern, and as indicated by the above authorities, exactly the same principles should apply in the development of ground-water.

Again we must distinguish between the well supply developed from pre-glacial valleys and from sand and gravel deposits elsewhere in the drift. Such deposits in the drift are sometimes more difficult to define as to location and extent, and generally are more limited in volume, and for this very reason they are more liable to failure unless thoroughly explored.

With these principles in mind it appears that the value of pumping tests, especially those limited to a few weeks or months, have been over-estimated. Pumping tests, except to secure samples of water are as a rule very deceptive and unnecessary.

Conclusion

The investigation of a new or of an additional water supply should be conducted along broad lines, keeping constantly in mind that such investigations may be properly extended a distance of 5, 10, 20 or even more miles beyond the city limits. A few comparisons in cost may show that a well supply can be developed at distances not heretofore seriously thought of. The present lower cost of cast iron pipe and the high cost of reservoir lands, are factors which will influence a final decision.

Keeping clearly in mind the fundamental principles which govern the development of a shallow ground-water supply, and realizing the relation thereto of deposits in the pre-glacial valley, it will be of interest to consider proper methods of development. These may be briefly summarized as follows:

1. An examination of the extent of all possible water-shed areas within reasonable distance. As a very rough rule, we might say that a city of 2,000 population can economically develop a well supply at a distance of not over five miles, while a city of 50,000 might economically develop a well supply at a distance of not over 15 or 20 miles, depending on availability of natural reservoir sites, relative elevations, cost of land, etc. The advantages of a well supply, with low first cost and low operating cost, will justify extending our investigations over a wider field than generally considered necessary.

2. An examination of well records, test holes, borings and other data in the territory under consideration. Such records can often be secured from coal, oil or gas companies, local well drillers, and of most importance in Illinois, through the State Geological Survey at Urbana. Some such records are confidential; but the portion relating to depth of glacial drift is not, and can generally be secured to be used in the investigation of a municipal supply.

3. A thorough study of all available records with a view to determining the dip of the rock or shale at base of glacial drift and the location of pre-glacial valley. This study should be made before the location of any additional drill holes is considered. Often the elevations as disclosed by the records of two or three old holes will indicate the direction of the pre-glacial valley, and a little further investigation should definitely establish its boundaries.

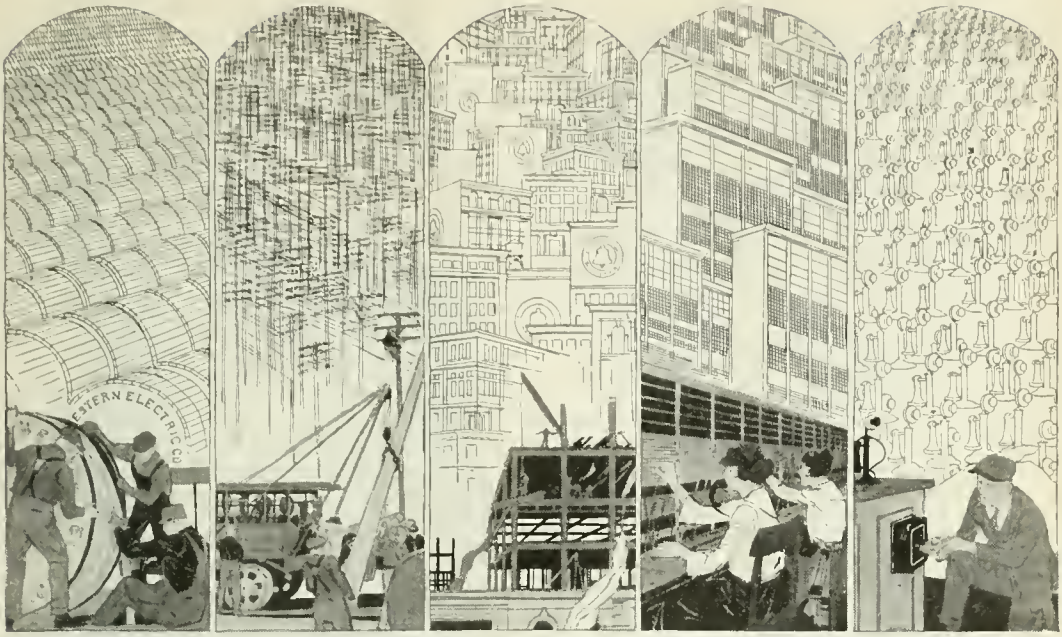
4. The application of knowledge obtained through these studies and the location of test holes in accordance therewith. Such test holes should furnish sufficient additional data to determine the possibilities of any site under consideration.

5. With complete and accurate data as to the fundamental principles which govern, a conclusion can then be reached as to the value of such a supply, compared with a surface supply, and recommendations made regarding future developments with a full knowledge that all facts relating thereto have been properly considered and analyzed.

In this connection it is interesting to recall the definition of Engineering: "Engineering is the art of directing the great sources of power in nature for the use and convenience of man."

In the deevlopment of ground-water supplies from pre-glacial valleys we may feel a certain professional pride in the fact that we are directing the great sources of power in nature for the use and convenience of man.

In final conclusion it is desired to point out that nature in her wonderful plan, provided many resources for our comfort and convenience, coal, iron, gas, oil, the precious metals, and most valuable of all, water. This water, filtered and stored for



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The foregoing paper by Mr. Warren was presented before the recent annual convention of the Illinois Section of the American Water Works Association.

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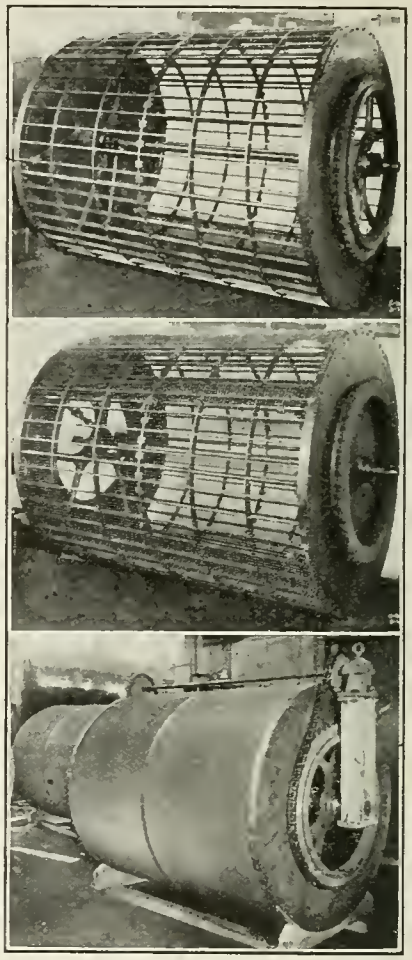

VIEWS OF THE TYPE OF SEWAGE SCREEN BEING INSTALLED BY THE SANITARY DISTRICT OF INDIANAPOLIS.

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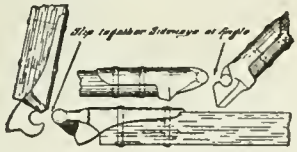

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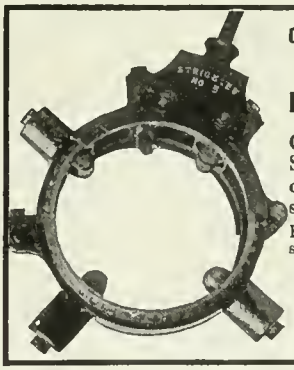

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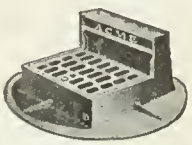

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Construction News and Equipment

FACTS AND FIGURES INDICATE THAT NOW IS THE TIME TO INSTALL PUBLIC IMPROVEMENTS

Since last September, there has been a decided drop in the cost of all materials entering into municipal construction work, in fact, all building materials as well. The municipal contractor has been standing outside anxiously awaiting an opportunity to resume his occupation and at the present time his keenness for work has somewhat subdued his good judgment, for never in the history of municipal work have prices been cheaper where work has been let. At our lettings, we have had from 20 to 40 contractors bidding on the work and each one has vied with his neighbor and practically bet that they could complete certain work at a profit, although, to the engineers, the work was let for so cheap a price that the contractors have seemed to face a loss from the start.

While the present conditions are bad for the municipal contractor, they are a great aid to the municipalities of the country provided the cities see fit to take advantage of these unusual conditions. At the present time, all municipal improvements are going in on a buyer's market, as has been ascertained by lettings held within the past two months. If the municipal officers of cities and villages throughout the country could realize the savings to be made through letting work at this time they would make an earnest effort and take immediate steps for the installation of such necessary improvements as may have been held in abeyance or may become necessary at this time.

These have to do with water works, sewers, electric light plants, pavements, curb and gutter, city parking, etc. These improvements, in many instances, have been put off during the war and since, to the detriment of the municipality.

These may be installed now at minimum cost to the taxpayer, whose payments may be spread in usual cases over a period of from 10 to 20 years to finance the improvements. There are many other advantages to be had at the present time, besides the low cost of the work. It is true that about 25 percent of the cost of any municipal work remains in the city or village in which the work is done. This is due to the employment of local labor by the contractor, repairs to equipment and machinery, purchase of fuels, oils, lumber, cement and other commodities, as well as the board and room and other incidental purchases made by any foreign labor. The spending of this money in itself means a considerable asset to the municipality. The progress of the improvement itself means another splendid advantage. The advertising the municipallty secures through doing the work also helps out. In many instances, the contractor simply "swaps" his dollars for the work so accomplished because of the extremely low prices he has to make to secure the work in competition with others.

Some Present Day Low Prices

When a municipality can obtain an 8 in. vitrified tile sewer 7 ft. deep, for 70 cts. a foot, 9 ft. deep for 80 cts. a foot and 11 ft. deep for 90 cts. a foot and 13 ft. deep for $1, with other prices of other sizes and depths of pipe in proportion; and water main at the following prices: 4-in. cast-iron, Class B, bell and spigot water main at 85 cts, 6-in. at $1.17 and 8-in. at $1.63, with other prices for valves and hydrants and fittings in proportion, it is certainly an advantageous time to let work. A 6-in. concrete pavement has been let as low as $2 per sq. yd., curb for 45 cts. to 70 cts. and sidewalks 11 to 15 cts. per sq. ft. Brick pavements were let including grading, curb and gutter and all other items, including engineering, at $4.62 per sq. yd. on a 6-in. concrete base with asphaltic filler. Warren Butulithic pavements per square yard have been let as cheap as $3.10, woodblock pavement with 3½-in. blocks, 16 lbs. penetration, has been let for $5.06, including concrete base, curb and excavation. Steel water towers and tanks have been going at greatly reduced prices, and while concrete towers and tanks can not be built as cheaply, their price has also been greatly reduced. A 150,000-gal. steel tank

on a 75-ft. tower of steel was recently let for $8,389 at De Smet, South Dakota. The cost of sewage disposal plants of the Imhoff type have been greatly reduced, as has also been the cost of building of pump houses, the furnishing of pumping equipment and the building of open wells.

Prices at Typical Letting at De Smet, South Dakota

A typical letting was held at De Smet, South Dakota, on April 27th, and so the readers of this article may have a comprehensive idea of such reduction in prices as has occurred, we are giving a resume of the bid of the successful contractor in Tables I and II. The remarkable thing about this letting was that the successful man was the low bidder by only $2,000. It should be noted that the water works system will be laid under splendid conditions in very wide streets. The sewer, however, will be laid under somewhat adverse conditions, being mainly located in 16-ft. alleys. Following is a tabulation of the prices of the low bidder and the engineer's estimate of cost.

In the tables the reader will see the itemized total prices bid as well as the itemized prices in the engineer's estimate, and he will conclude that the contractor stripped himself to the bare bone and that as the plans and specifications are rigid and must be followed in their entirety, the contractor is practically "swapping" dollars. If it were not for the sewers being installed in the alleys, he might be able to make a fair profit. The only advantage to a contractor must, therefore, be through having given his organization work. Such prices throw a considerable burden upon the consulting engineers in charge of the work, because, when a contractor is making a fair profit he is more willing to carry out the details of the construction work than he is on a losing proposition.

So that this contractor may complete his work in the shortest possible time, he is placed under penalty of $1,000 per month, which $1,000 per month is deducted from the amount of the contract from start to completion of the work. All water mains, hydrants, valves, fittings, etc., are inspected at the foundries and all material used throughout the construction must be first class in every respect. The cement entering into the construction of the disposal works, well and pump house, is all tested in accord-

TABLE I—COMPARISON OF CONTRACT PRICES WITH ENGINEER'S ESTIMATE ON COMPLETE SEWER SYSTEM AT DE SMET, SO. DAK.

Quantity.	Item.	Contract Price. Price. Unit	Contract Price. Total.	Engineer's Estimate. Price. Unit	Engineer's Estimate. Total.
1,400 ft.	8 in. vit. tile sewer 5-7 ft. deep...	$ .70	$ 980.00	$ 1.00	$1,400.00
7,500 ft.	8 in. vit. tile sewer 7-9 ft. deep...	.75	5,625.00	1.15	8,625.00
5,200 ft.	8 in. vit. tile sewer 9-11 ft. deep...	.85	4,420.00	1.40	7,280.00
2,400 ft.	8 in. vit. tile sewer 11-13 ft. deep...	1.00	2,400.00	1.80	4,320.00
500 ft.	8 in. vit. tile sewer 13-15 ft. deep...	1.37	685.00	2.50	1,250.00
300 ft.	8 in. vit. tile sewer 15-17 ft. deep...	1.40	420.00	3.40	1,020.00
500 ft.	10 in. vit. tile sewer 5-7 ft. deep...	.80	400.00	1.20	600.00
600 ft.	10 in. vit. tile sewer 7-9 ft. deep...	1.00	600.00	1.40	840.00
500 ft.	10 in. vit. tile sewer 9-11 ft. deep...	1.15	575.00	1.60	800.00
400 ft.	10 in. vit. tile sewer 11-13 ft. deep...	1.40	560.00	2.00	800.00
100 ft.	10 in. vit. tile sewer 13-15 ft. deep...	1.60	160.00	3.00	300.00
200 ft.	10 in. vit. tile sewer 15-17 ft. deep...	2.60	520.00	3.70	740.00
500 ft.	12 in. vit. tile sewer 5-7 ft. deep...	.90	450.00	1.60	800.00
30 ft.	12 in. vit. tile sewer 7-9 ft. deep...	1.00	30.00	1.80	54.00
400 ft.	12 in. vit. tile sewer 9-11 ft. deep...	1.20	480.00	2.20	880.00
1,000 ft.	12 in. vit. tile sewer 11-13 ft. deep...	1.45	1,450.00	2.80	2,800.00
150 ft.	12 in. vit. tile sewer 13-15 ft. deep...	1.70	255.00	3.25	489.00
700 ft.	15 in. vit. tile sewer 5-7 ft. deep...	1.50	1,050.00	1.85	1,295.00
300 ft.	15 in. vit. tile sewer 7-9 ft. deep...	1.65	495.00	2.00	600.00
300 ft.	15 in. vit. tile sewer 9-11 ft. deep...	1.94	582.00	2.40	720.00
200 ft.	15 in. vit. tile sewer 11-13 ft. deep...	2.24	448.00	2.90	580.00
200 ft.	6 in. house chimneys	1.50	300.00	.50	100.00
560	8x6 in. Y branches	1.70	952.00	1.50	840.00
75	10x6 in. Y branches	2.40	180.00	2.00	150.00
65	12x6 in. Y branches	3.00	195.00	3.00	195.00
30	15x6 in. Y branches	4.00	120.00	4.00	120.00
58	Manholes	75.00	4,350.00	75.00	4,350.00
4	Lampholes	20.00	80.00	20.00	80.00
20	Cu. yds. rock excavation	3.00	60.00	7.00	140.00
10,000	ft. B. M. sewed lumber per M. B. M.	20.00	200.00	40.00	400.00
15,000	sq. ft. sheeting and bracing, per M. sq. ft.	25.00	375.00	50.00	750.00
10	cu. yds. 1:2½:5 concrete	12.00	120.00	12.00	120.00
	Total		$29,517.00		$43,436.50
1	Imhoff tank complete	.....	5,468.00	.....	6,000.00
	Sludge bed and by-pass	.....	1,050.00	.....	1,200.00
1,000	15 in. drain tile 3-5 ft. deep	.90	900.00	.75	750.00
350	15 in. drain tile 5-7 ft. deep	.90	315.00	1.00	350.00
10	cu. yds. concrete 1:2½:5	15.00	150.00	12.00	120.00
	Total		$37,400.00		$51,856.50

TABLE II—COMPARISON OF CONTRACT PRICES WITH ENGINEER'S ESTIMATE ON COMPLETE WATER WORKS SYSTEM AT DE SMET, SO. DAK.

Quantity.	Item	Contract Price— Unit Price.	Contract Price— Total.	Engineer's Estimate— Unit Price.	Engineer's Estimate— Total.
16,500 ft.	6 in. C. I. pipe complete, 7 ft. trench.	$1.17	$19,305.00	$1.30	$21,450.00
7,000 ft.	8 in. C. I pipe complete, 7 ft. trench.	1.63	11,410.00	1.80	12,600.00
50 ft.	10 in. C. I. pipe complete, 7 ft. trench.	2.90	145.00	2.50	125.00
3	4 in. gate valves and boxes (cut in)	19.00	57.00	25.00	75.00
31	6 in. gate valves and boxes (cut in)	25.50	790.50	35.00	1,085.00
13	8 in. gate valves and boxes (cut in)	37.00	481.00	45.00	585.00
1	10 in. gate valve and box (cut in)	65.00	65.00	60.00	60.00
44	(6 in. base elbow) hydrants	75.00	3,300.00	75.00	33.00
21,000	lbs. C. I. specials per lb. installed	.07	1,470.00	.08	1,680.00
4	2½ in. overhead sprinkler cranes (each)	43.00	172.00	40.00	160.00
10	cu. yds. rock excavation	3.50	35.00	7.00	70.00
3	M. ft. B. M. sawed lumber, per M. B. M.	20.00	60.00	40.00	120.00
4	M. sq. ft. sheeting and bracing, per M. sq. ft.	40.00	160.00	50.00	200.00
16	cut-ins	30.00	480.00	10.00	160.00
			$37,930.50		$41,670.00
150,000	Gallon steel tank on 75 ft. steel tower		$8,945.00		$9,000.00
	Pump house inside dimensions 22x22 ft. in ground 10 ft. deep, 11 ft. to eaves above ground level		2,834.00		3,085.00
	Well 18 ft. - 0 in. dia. x 25 ft. - 0 in. deep		2,899.00		3,000.00
	Mechanical equipment, lighting. Mechanical equip. consisting of 150 gal. triplex, 500 gal. centrifugal (Worthington), 1-40 H.P. and 1-15 H.P. G.E. slip ring motor, switch panel, etc.		5,868.00		.....
			$58,476.50		$63,555.00

ance with the standards of the American Society of Testing Materials. At this letting there were some 70 contractors and material men present. About 40 sets of plans and specifications were out for figures and 27 actual bids were received. The contractor has agreed to take $70,000 worth of bonds at 5¾%. This proves the statement that now is the accepted time to proceed with municipal improvements and will show officials that large savings can be made to the taxpayers by so doing. The period in which construction may be done in the middle west is such that if improvements are to be made, this year, steps must be taken at once so that an early letting may be held.

MOTORIZING THE FRESNO SCRAPER

By E. M. Lagron, The Holt Manufacturing Co., Peoria, Ill.

The Fresno or "Buck" Scraper is by no means a new tool in the hands of road building contractors. This piece of equipment has a long established record for economy in moving dirt a short distance, in road building, railroad work, levee building, land leveling and other similar work. Three-up and four-up teams with 4-ft. and 5-ft. Fresnos have made records which would have been impossible for any other method, so far as daily yardage is concerned.

Primarily designed to operate in loose, sandy soil, Fresnos within the last few years have proven their value by being successfully used in gumbo, hardpan, loose rock, gravel, heavy clay, black-jack and other severe soil conditions. Experience has taught that even the toughest and most resistent soil, after being plowed, may be economically handled by Fresnos on the shorter hauls at an extremely, and in fact, an astonishingly low cost per yard.

To those who are conversant with this form of dirt moving, this tool warrants no further discussion, but this article is directed to those who have not familiarized themselves with the usefulness and operating range of the Fresno.

Recent Improvements in the Fresno.

Recently considerable improvement has been made on the design and construction of the Fresno, and although originally intended to work with teams, they are now built for tractor operations. Their value, consequently, has increased two-fold. Daily yardages, decidedly impossible to realize with team-drawn Fresnos, are being consistently made by tractor Fresno outfits. Special hitches and larger Fresnos with particular loading and dumping devices, have made the tractor Fresno outfit a complete success. The loading and dumping is now being done by the operator from the seat of the tractor by means of powerful levers and pull ropes.

The 7-ft. Fresno holds approximately 20 cu. ft. of loose dirt. This size is not applicable to teams, but because of the

extra large load it carries and the power required to load it, it has been designed primarily for use with the smaller sized "caterpillar" tractors.

This scraper outfit not only takes a load that would be impossible for teams, but the tractor carries it for distances which would be entirely out of the range of teams. Only under the most extreme circumstances are Fresno team-drawn outfits used on a haul any longer than 200 ft. With the tractor-Fresno outfit, however, such distances have been handled at an extremely low cost per yard, and the yardage per day on such hauls has been known to average between 160 to 200.

Those who are contemplating handling their Fresno work with tractors should note that the greatest precaution should be exercised in the selection of both the scraper and the tractor. Although this outfit includes possibilities of handling work in an effective, efficient and highly profitable manner, unless the Fresno is strong enough to stand the constant punishment that the tractor will subject it to, a weak link will develop. The converse is equally true and if the tractor has not the "staying" qualities of workmanship and material in it to warrant standing up under continuous hard usage, the outfit can not succeed. For these reasons, it behooves those who are investigating this class of work to assure themselves that only the very best of this class of equipment is on their particular job.

Records on One Job.

The operation illustrated in this article is one which is proving extremely profitable. Engineer Ladd, when asked for information concerning the performance of this outfit, stated:

"We are hauling a yard of sand 200 ft. up a 20% grade in Lincoln Park, laying the foundation for the million-dollar Spreckels Soldiers' Memorial Building. The round trip is made in three minutes, and I am satisfied that the "caterpillar" and Fresno outfit can do the work of sixteen horses, or four-up scraper teams."

The cost of 16 head of stock, which Mr. Ladd estimates is replaced by the tractor Fresno outfit, is well known. The cost of operating the motorized outfit, based upon an almost uniform record, is as follows:

DAILY OPERATING COST

1 Tractor Operator @ $4.00	$ 4.00
Gasoline, 15 gal. @ 22c	3.30
Oil, 1 qt. @ 20c	.20
Grease	.25
Interest, depreciation, insurance and repairs	6.90
Total daily operating cost	$13.65

These costs as quoted, of course, are subject to local labor costs and other variables, but are fairly accurate, based upon conservative general conditions. The cost of the motorized outfit is less per day than the cost of four skinners for the four-up teams, which are easily required to do an equivalent amount of work. Added to this, the cost of team operation, feed, stable equipment, shoes and harness, which enter into team operations, and the decided contrast in favor of the tractor Fresno outfit, is quickly and obviously seen. The increased capacity and efficiency of the motorized Fresno outfit is even more pronounced in extremely hot weather, when teams are put out of business or their efficiency reduced far below normal.

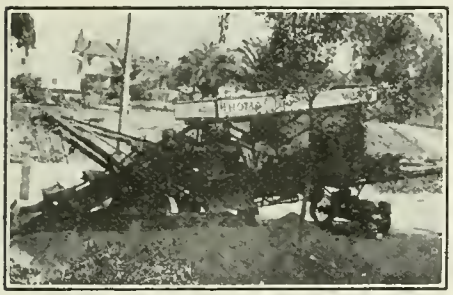
Referring again to Mr. Ladd's statement, in which he advises that he can average a round trip on a 200-ft. haul up a 20% grade in three minutes, we are reasonably safe in assuming that by deducting for unavoidable delays, 8½ hours per day would well represent actual working time. At this rate 170 yds. of dirt were moved by the motorized 7-ft. Fresno outfit. The cost of this operation would be $13.65 per day, or the cost per yard would be 8c.

A MOTORIZED FRESNO SCRAPER IN OPERATION.

Certainly this is a very remarkable showing, and should warrant the closest scrutiny of those interested in this class of work. Using Fresnos on a 200-ft. haul is an extreme condition in the first place, but to move 170 yds. per day at 8c per yard is an enviable record.

MACHINE TRENCHING TO A DEPTH OF 30 FT. AT ONE OPERATION

Thomas Haverty & Co., the well-known Los Angeles plumbing contractors, many years ago became firm believers in machine trench digging. They recently gained considerable attention through the digging of a 30-ft. by 30-in. trench at one operation. Since the P&H Ladder Type Trencher is designed for depths to a maximum of 18 ft., many looked upon this feat with doubt. However, those who



P & H LADDER TYPE TRENCHER EQUIPPED WITH BOOM EXTENSION CUTS TRENCH 30-FT. DEEP AND 30-INS. WIDE AT ONE OPERATION, LOS ANGELES, CALIF.

went to see the job found that a boom extension had been added (not recommended by the manufacturer, Pawling & Harnischfeger Co., Milwaukee, Wis.) Averages of 45 to 50 ft. per hour of deep trenches have been dug—720 ft. being dug with this machine working up 5 percent grade in one day. With the standard machine as shown in the accompanying illustration, 552 lin. ft. of 9 to 12 ft. deep trench 30 ins. wide was dug in four hours, working up an 8 percent grade.

NEW POWER SHOVEL USES A DIESEL TYPE ENGINE

After a long period of experimentation the Bucyrus Company has developed the use of a Diesel type engine for a power shovel. The importance of this announcement lies principally in one outstanding fact: the fuel cost. This shovel, known as the Bucyrus 30-B oil shovel, will use as fuel any cheap, low-grade oil of high heat value which will flow freely.

The saving in the cost of fuel thus obtained is almost unbelievable. This machine has been under severe test for several months, under strenuous winter conditions, both as a shovel and as a dragline. These tests have shown that with fuel oil at 6c per gallon this machine will consume 1¾ to 2¼ gals. of fuel oil per hour. This means a fuel cost of 10½c to 13½c per hour, or, roughly, between $1 and $1.25 per day of average operation.

The phenomenal economies thus made possible to a shovel or dragline operator may be realized by comparison with a steam shovel of the same size. The fuel cost of any shovel differs widely in different sections of the country. Conservatively stated, however, such a shovel will burn about 1½ tons of coal in 10 hours. With coal at $6 per ton delivered, this means a daily fuel cost of not less than $9. A saving of $8 per day on fuel alone is thus possible. To this figure may be added several other items thus eliminated, notably, the saving made possible in not having to pay the cost of a team to haul water and coal.

To bring this home a little more forcefully, the resulting saving should pay the wages of the operator for the day with a considerable balance to spare.

The engine is of the full Diesel type, not the semi-Diesel. It is what is known as a mechanical injection engine, developing 55-H.P. at the conservative speed of 360 R.P.M. Its cylinders are 8 x 10½ ins. It is a heavy duty, slow speed engine of particularly rugged and heavy construction, adapted well to the severe service it must undergo in excavation work.

This Diesel type engine differs from the gasoline engine principally in that it is a constant pressure engine, the fuel being burned directly in the cylinders without the aid of a carburetor, spark plug or outside heating appliances. In the gasoline engine the mixture is taken into the cylinders, compressed, and then ignited by some auxiliary mechanism. The pressure then rises in the nature of an explosion. In the Diesel type engine the fuel is injected into the cylinders at a constant pressure in an atomized state. It is fired by the heat developed by the compression of air in the cylinders on the previous stroke. Thus the sudden pressure due to the explosions in the gaso-

line engine is eliminated, making the engine steadier running and easier to maintain.

The Diesel type of engine is no more of an experiment than a steam engine and is equally reliable. It is of a well tried design, being based on 20 years of engine builders' experience. Its especial value is the very low grade fuel that can be used with entire satisfaction, thereby revolutionizing the cost of operation for a machine of this size.

The 30-B oil machine, equipped with a Diesel engine, may be furnished either as a shovel, a dragline, a clamshell or a locomotive crane.

More detailed information may be obtained from the Bucyrus Company, South Milwaukee, Wis., upon application.

BUCYRUS POWER SHOVEL OPERATED BY A DEISEL TYPE OF OIL ENGINE.

CORE DRILLING MACHINE TEST CAUSES REJECTION OF AN INDIANA PAVEMENT

In making final settlement with a road contractor the Indiana State Highway Commission recently refused to pay for 1,128 ft. of concrete pavement which is not of the thickness required by the specifications, and $5,700 was deducted from the final estimate given the contractor.

The "gift" pavement comes as a result of the activities of the highway department in using a core drilling machine to test all pavements before receiving them and making final settlement, and in this case it was disclosed that certain parts of the pavement were not up to the specifications. The discovery has also resulted in five inspectors and engineers employed by the highway department on this particular project being dismissed.

The work of the core drilling machine and the taking over of 1,128 ft. of pavement on this road, divided into intervals of 100 ft. or more in stretches extending for approximately 11 miles between Dyer and Deep River in Lake County, brings to light some interesting facts in state highway construction.

According to commission members the pavement in question is, to the eye, apparently up to every requirement. However, when the core drilling machine was put to work cutting out cores every few feet to determine the thickness of the pavement, it was disclosed that materials were skimped and the thickness on the sides as well as in the crown of the highway were deficient of specifications over a distance of 1,128 ft. The commission refused to settle with the contractor for this inferior mileage, leaving the builder the alternative of tearing up and rebuilding this section, or giving the inferior pavement to the state. The latter selection was made. It is now up to the state to rebuild this section when it goes bad.

The core drilling device was added to highway department equipment several months ago for the express purpose of seeing that roads are built of the thickness required by the specifications. There is no getting away from the final results, for when a core is removed from a completed pavement prior to final settlement between highway department and contractor, the commission knows positively if the road is up to standard.

SANITARY SEWERAGE SYSTEM

Notice to Bidders

Huntingburg, Ind.

Sealed proposals will be received by the "Honorable Mayor and Common Council" of the City of Huntingburg, Ind., until 8 P. M., June 6th, 1922, at which time they will be publicly opened and read.

A cashier's check or certified check on a local bank, to the amount of $5,000.00 made payable to the City Clerk must accompany each bid.

The sewer work consists of approximately 8 miles of 8 in. to 12 in. sewers, 91 manholes, 9 flush tanks and settling tank.

Proposals must be marked "Proposal for Sanitary Sewerage System."

The city reserves the right to reject any or all bids.

A set of plans and specifications may be obtained from the engineer upon a deposit of $16.00. Specifications only, $6.00 deposit. Any one plan, $4.00 deposit. Seventy-five per cent of all deposits will be refunded upon the return of plans and specifications to the engineer's office not later than June 16, 1922. Bid sheets are in the specifications, and a bid submitted will also be considered a return of the specification.

Louis Wagner, Mayor.
Cossie M. Day, City Clerk.

Frank L. Wilcox, Engineer,
Chemical Building,
St. Louis, Mo.

FOR SALE

Best 60 H.P. Track-laying tractor, overhauled, repainted, practically as good as new. Immediate delivery. For price and special terms, address

H. W. Chown,
305 Merchants Bank Bldg.,
Indianapolis, Ind.

Contracts Awarded

ROADS AND STREETS

Ala., Athens—A. J. Waldrop, Knoxville, Tenn., will probably be awarded contr. by St. Hwy. Dept., for constr. of hard surf. rd., from Athens to Lauderdale. Bid on mac. penetration $384,101; on conc. penetration, $422,690.

Ala., Birmingham—Following roads contracts let; Ensley, Hulga, Wylam & Docena Roads to Independent Paving Co., at $223,029; Warrior to Robbins crossroads to C. P. Parsons, at $61,300; Mulga-Port of Birmingham Rd., to Wallace Bros., at $62,350.

Ala., Florence—Goodson Constr. Co., Knoxville, awarded contr. for construction of Rogersville Rd., at $165,000 (14 miles).

Ark., Marion—U. V. Thornton, Searcy, Ark., awarded contract by Critenden Co., Commrs., Dist. No. 6, at $350,000; 30 mile gravel rd. around Earle.

Cal., Oakland—Heafy, Moore & McNair, awarded contract for constr. of modern conc. roads betw. Hayward and St. Eden and bet. E. 14th St. and San Lorenzo, at $117,655.

Colo., Sacramento—Standard Industrial Engrg. Corp., San Francisco, awarded contract for grading and surfacing with gravel 10.98 mi. state hwy. in Monterey Co., betw. San Lucas and 2¾ mi. east of Long Valley school, at $138,830.

Colo., Colorado Springs—The Stratton Est., awarded contract by Council for paving city and street-car portion of paving program, including right-ofo-way of street car lines on 4 streets, at $151,007.

Ga., Atlanta—MacDougal Constr. Co., Healey Bldg., awarded constr. for 14,190 sq. yds. Marietta St.—Peachtree to Bartow Sts., at $99,049; 3675 sq. yds. Decatur St.—Peachtree to Ive Sts.—at $25,652; foregoing with granite blk. on conc.; 10,305 sq. yds. Decatur St.—Ivy to Yonge Sts., conc., $71,351.

Ind., Indianapolis—Carpenter Constr. Co., Terre Haute, awarded contract by State Hwy. Commission to pave one sect. of National Hwy.—stretch of 6.897 mi. bet. Putnamvill eand point 1½ miles east of Mt. Meridian—with brick at $210,916.78. Road will have conc. base.

Kans., Garden City—M. R. Ammerman, Wichita, awarded contract to build 6 miles hard surf. roads in Finney Co., at $174,000.

Kan., Topeka—Stewart & Ritchie, Wichita, awarded two paving contracts at $154,812; List & Hallett, Kans. City, Mo., contr. for Elmont spur paving at $69,308.

Md., Baltimore—L. R. Wacache, Thurmont, Md., awarded contract to construct 1.99 mi. St. Hwy. from end of Cont. F-27A to Urbana, at $49,990 (Concrete); Warp Bros. & Pyles, contr. to constr. 3.34 mi. St. Hwy. on York Rd., Baltimore Co. Cont. B-35, at $85,600; Thomas, Bennett & Hunter, contr. to construct 3.75 mi. St. Hwy. from New Windsor to Union Bridge, Carroll Co. Cont. C1-25, at $123,885; E. R. Griffith, Contraction Co., at $109,182, to construct 4.19 mi. St. Hwy. along Philadelphia Rd. to Bush; conc., Harford Co., Cont. 4-27.

Mass., Boston—D'Onfro Bros., 700 Main St., Leo-

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minster, awarded contract by St. Hwy. Dept. for paving 14,000 ft. highway, Palmer & Madison, rein. conc. at $149,536; Coleman Bros., Medford St., Charlestown, awarded contract for paving 56,000 ft. Newburyport Turnpike, Danvers & Topsfield, 18 ft. rein. conc. and bitum. macadam, at $503,831; 3500 ft. hwy. Bingham, 18 ft. conc. and bitum. macadam, to J. D'Aloi, Woonsocket, R. I., at $37,458.

Mass., Springfield—Candella Co., Milford, Mass., awarded contract for bldg. Southwick and Granville Rd., at $301,531.

Mich., Ironwood—W. S. Peters, Wakefield, awarded contract for construction of Tula Rd., at $112,000; macadam, 10 miles from Wakefield to Tula.

Neb., Chadron—Roberts Constr. Co., 404 First Natl. Bank Bldg., Lincoln, awarded contract for constr. of Paving Dist. No. 2 ;Topeka type asphalt paving, at $125,837.

N. J., Freehold—J. J. Barrett, 147 Lafayette St., Trenton, awarded contract for reconstructing Ocean Ave., Sea Bright and Monmouth Beach Boros.; sheet asph., at $160,000; Utility Constr. Co., 5 Spring St., New Brunswick, awarded contract for reconstr. of State Hwy., Route 4, Sec. 6, Etontown to W. Long Branch; sheet asph. on conc., at $187,569.

N. J., Red Bank—S. S. Thompson & Son, Red Bank, awarded contract for reconstr. of Adelphia-Farmingdale conc. road, at $118,183. Road is 3½ miles in length, 20 ft. wide .

N. J., Trenton—Michael Straub, awarded contract by Gloucester Co., for constr. of sect. of Camden-Salem Rd., also one for bldg. Adelphia-Farmingdale Rd. Monmouth awarded to S. S. Thompson, Inc., Red Bank, at $203,660 and $118,882, respectively.

N. M., Santa Fe—Following road contracts let on No. 78, San Miguel Co.—Las Vegas to Watrous, 17.7 miles; grading, draining and crushed limestone surfacing, to Atlas Constr. Co., at $80,338; McKnight & Hamer, Amarillo, Tex., contract for similar work on 33.8 miles, FAP 79, at $74,343; J. R. Dooley, Santa Fe, constr. for 12.8 mi. Moreno Valley; grading, draining, gravel and crushed rock surfacing at $54,912.

N. Y., Albany—Following contracts let for impvt. of 2.47 mi. Hwy. 1613, Broome Co. to J. C. Haynes, Watertown, $97,620; 6.6 mi. Hwy. 1613, Broome Co., to Stento & Serafini, 84 Court St., Binghamton, at $166,164; 2.84 mi. Hwy. 1480, Cattaraugus Co. to Cold Spring Constr. Co., Ellicott Sq., Buffalo, at $96,646; 1.91 mi. Hwy. 1611, Cattaraugus Co. to G. Metzger, Jr., 12 E. 4th St. Emporium, Pa., at $61,152; 3.5 mi. Hwy. 8091, Fulton Co. to Norwich Constr. Co., Inc., Norwich, at $91,158; 2.76 mo. Hwy. 1481, Monroe Co to F. W. and J. J. Crouch, Rochester, $68,734; 1.06 mi. Hwy. 1610, Oneida Co. to N. D. Peters &Co., 216 Kossuth Ave., Utica, $52,804; 8.08 mi. Hwy. 8092, Wyoming Co., to Constantine Constr. Co., 240 Dewey Ave., Buffalo, at $333,302.

N. Y., Geneva—J. H. Gallup, Union Blk., Syracuse, awarded contr. for paving various streets; sheet asph. on 5-in. conc., at $101,777.

N. Y., Watertown—Bd. of Supvrc. Jefferson Co., will construct 50 miles macadam hwys. by Day Labor, under supervision of H. S. Ball, County Bldg., Co. Supt. of Hwys., Arsenal St., at $350,000.

N. C., Raleigh—State Hwy. Comm., let contract for grading and penetration macadam paving 5.96 mi. State Proj. 866, Polk Co., to Dunn & Woodall, Trust Co. of Georgia Bldg., Atlanta, Ga., at $144,-144; 4.49 mi. St. Proj. 492, Warren Co. to Porter & Peck, Greenville, at $86,840; grading and topsoiling 4.5 mi. State Proj. 724 Caldwell Co. to Caldwell Co., Rd. Comm., Lenoir, at $24,440; rein. conc. bridges and culverts to R. M. Thurmond, Lynchburg, Va., at $22,620; 3.07 mi. St. Proj. 601, Alexander Co. to G. Ginn, Inc., Gastonia, $18,539; Rein. conc. brdges. & Culvts. to R. M. Thurmond, Lynchburg, Va., $13,000; grading, paving, 2-in. Topeka on 5-in. conc, 10 mi. State Proj. 903, Buncombe Co. to Asheville Paving Co., Asheville, at $85,163; clearing, grading & waterbound macadam surfacing 11.85 mi. State Proj. 951, Jackson Co. to R. H. Wright & Son, Asheville, $189,250; grading, rein. conc. paving and rein. conc. brdgs. and culverts on 8 miles Stfl Proj. 588, Rockingham Co. to Cheatwood & Driscoll, Richmond, Ca., at $242,280.

O., Paulding—Sol Putnam, Van Wert, awarded contract for bldg. no. port of Wayne Hwy. Van Wert Hwy., at $149,997.

Ore., Baker—Oxman & Harrington awarded contr. by County Court for constr. of Baker-Cornucopia post road, at approx. $108,000. Work involves grading 13½ miles.

Ore., Portland—Simon & Johnson, awarded contract for impvt. of Foster Rd. from Powell Valley rd. to E. 72nd st., at $152,303.

Ore., Portland—Montague-O'Rielly Co., awarded contract for grading Carvice Creek section of John Day Hwy., Gilliam Co., 11 miles, at $154,350.

Pa., Harrisburg—Dunleavey Brothers Co., Coatesville, Pa., awarded contract to build 15,128 ft. one-course rein. conc. and Hillside vit. brick roadway on Route 225, Radnor Twp. Delaware Co., at $134,758.

Pa., Phila.—Contract let for paving Lancaster Ave. and 5th St. to Barber Asphalt Paving Co., Land Title Bldg., at $55,600 and $39,000 respectively; grading Jefferson St., to E. A. Mullen, 5512 Vine St., $28,200; furnishing and setting granite and conc. curbs in various streets, to J. J. McHugh, 1430 S. Penn Sq., at $69,000.

Pa., Shippensburg—Development & Constr. Co., Baltimore, awarded contract for road work in Cumberland Co., at $204,322. Proj. calls for 34,526 ft. one-course rein. conc. roadway, 16 ft. wide.

Pa., Williamsport—Busch & Stewart, Williamsport, Pa., awarded contract for 22,000 sq. yds. 4-3 in. vit. brk. pavink on Park, Campbell, Walnut, Hepburn, Front, Court, Jefferson and Oliver Sts., at $88,100; Central Constr. Corp., Harrisburg, Pa., awarded contract for 42,859 sq. yds. 3-in. Trinidad sheet asph. paving on Park Ave., Franklin and W. Third Sts., at $153,293.

S. C., Greenwood—City let paving contracts as follows: Case & Cothran, Atlanta, Ga., 50,000 sq. yds. roadway pavement; Greenville Paving Co., Greenville, S. C., 18,000 yds. walk paving; both conc., at total cost of $200,000.

Tenn., Lawrenceburg—Smith, Pitts & Son, Mt. Pleasant, Tenn., awarded contract to grade and surface 15.65 mi. St. Hwy. 51 bet. Lawrenceburg and Wayne Co. line, Lawrence Co., at $103,854.

Tenn., Memphis—Hansen Constr. Co., Blytheville, Ark., awarded contract for conc. surfacing of road from Marked Tree to no. line of Crittenden Co., at $260,000. Hwy. will be about 10 miles in length.

Tenn., Nashville—Hughey Bros., Memphis, Tenn., awarded contr. for 12 miles of road, Carroll Co., at $90,000; Moore Brothers, awarded contract for chert surfacing 20 mi. rd. Lewis & Lawrence Cos., at $63,000.

Tenn., Nashville—Smith, Pitts & Co., Mt. Pleasand, Tenn., awarded contract for 15 miles of highway at $103,854.

Tex., Amarillo—Plains Paving Co., Wichita Falls, Tex., awarded contract for paving at $450,000.

Tex., Dallas—Uvalde Paving Co., awarded contract to pave Clinton St.,—King's Hwy. to so. city limits—at $93,000.

Tex., San Angelo—O'Connor, Smith & Co., Dallas, Tex., awarded contract to pave 4 miles streets, at $263,000; also at $40,800 to pave 4 suburban blks.

Tex., Wichita Falls—Wichita Co. Judge, J. P. Jones sublet contr. to Tibbetts Constr. Co., 209½ W. 8th St., Ft. Worth, for constr. of 4.2 mi. conc. pavement betw. Wichita Falls and Clay Co. line at $129,702. McCollum Constr. Co., 1507 F. & M. Bank Bldg., Ft. Worth, to constr. 4.4 mi. conc. paved rd. no. of Electra, at $143,997.

Va., Charlottesville—Maloney Paving Co., 3817 Alton Pl., N. W. Washington, D. C., awarded contract to construct conc. paving, 15 ft. wide and 5-7-5-in. deep, at $125,000.

Va., Pearisburg—Worden Constr. Co., Pulaski, Va., awarded contr to construct 6.19 miles bitum. macadam betw. Ripplemead and Hoge's Store, Route 23, Giles Co., Proj. 128-A at $119,134.

Wn., Hoquiam—Grays Harbor Constr. Co., local awarded contr. for paving 4-mile stretch of Olympia Hwy. betw. Montesano and Brady, at $105,452.

Wash., Seattle—Jahn & Bressi, Thompson Bldg., Seattle, awarded contract for brick paving on First Ave, and First Avenue south, at $649,199.

Wn., Seattle—D. W. Miley, Everett, awarded contract by Board of Skagit Co. Commrs., to pave 6½ miles of highway betw. Hamilton and Lyman with 7-in. concrete, at $143,624.

Wn., Seattle—McHugh Constr. Co., awarded contract for clearing, grading, draining and paving with one course conc. about 4.18 mi. Sunset Hwy. betw. Sunnyslope and East Cashmere in Chelan Co., FAP 99, at $129,834; clearing, grading, etc. abt. 3.71 mi. Olympia Hwy. betw. McCleary and

Thurston Co. line, Grays Harbor Co. FAB 101, to Indiana Asph. Paving Co., Seattle, at $118,653; similar work on 1.40 mi. No. Bank Hwy. bety. Ellsworth and Camas, Clarke Co., FAP 36, to G. P. Warren, Seattle, at $39,168.

W. Va., Charleston—State Road Commission awarded following road contracts: Smith & Qwynn, Parkersburg, W. Va., awarded contract for 5.3 mi. conc. at $150,600, Wood Co.; J. M. Lipscobe & Bro., Glenville, W. Va., 8.77 mi. Webster Co. at $85,303; 5.27 mi. Bitulithic conc., Ritchie Co. at $187,370 to Smith & Qwynn; Cisler & Morse, Marietta, Ohio, 3.76 mi. conc., Monongalia Co., at $138,272; R. H. Anderson, Fayetteville, W. Va., 1.48 mi. Kanawha Co.; 1.6 mi. conc., to Cisler & Morse, Marietta ,O., Marion Co., at $56475; Jno. E. Dougher & Sons, Union, W. V., awarded contr. for .98 miles bilulithic macadam at $29,000; Thompson & Doss, Barboursville, W. Va., contr. for .84 mi. conc. Logan Co. at $31,600; Roane Co., 3.7 mi. conc. at $116,660 to Cisler & Morse, Marietta, O.; .13 mi. grading, Mingo Co., at $4842 to Rogers & Shumway, Worthington, W. Va., at $4,832; 1.91 mi. conc., to Engstrum & Knapp, Wheeling, Ohio Co., at $72,876! 4.24 mi. conc. at $171,017 to Paul S. Haner Co., Clarksburg, Harrison Co.; 2.03 mi. Bithulithic macadam at $69,900 to E. K. Newell, Waynesville, Ky., at $69,900; 5.49 mi. Gravel, Mason Co. to Tulley Constr.

WIS., Elkhorn—Following contracts let for constr. of 17 miles conc road in Walworth County: Elkhorn-Burlington Roads, Henry Horst, Rock Island, $129,787; Lake Geneva-Walworth Rd., States Impvt. Co., Chicago, Ill., at $127,848.

Wis., Janesville—R. R. Birddall, Racine, awarded contr. for constr. of Beloit-Delevan and Beloit-Clinton Roads; 7 miles, at $108,471.

Wis., Jefferson—Following contracts let for road work: Jefferson-Ft. Atkinson Rd., Proj. 296, to Webb & Dixon, Albany, at $97,619; Jefferson-Cambridge Rd. Proj. 28, to Jos. P. Connell, Janesville, at $32,147; Jefferson-Johnson Creek Rd. Proj. 254, to Jos. Connell, Janesville, at $78,348.

Wis., Racine—L. L. Tindall, Waterford, awarded contract for constr. of Windlake Rd., at $122,814.

Wis., Sheboygan Falls—Robert Reisinger Co., 464 Oakland Ave., Milwaukee, awarded contract for paving at $106,905; 2-course conc. 24,000 sq. yds. rein. conc., 5900 sq. yds. conc., 832 sq. yds. paving in street car section, 12,000 cu. yds., grading.

Wis., Wisconsin Rapids—Following contracts let for road work: Wisconsin Rapids-Pittsville-Neillsville Rd., to Niehaus & Stahl, Greenleaf, at $52,476; Marshfield-Pittsville-Babcock Rd., to Ule Paving Co., Stevens Point, at $63,779; Rudolph- Rapids Rd., to Peppard & Fulton, Superior, at $58,360.

Wis., Wisconsin Rapids—Marshfield-Neillsville and Marshfield-Pittsville-Babcock Rds. contract let to Iron River Constr. Co., Iron River, Mich., at total of $130,343.

SEWERAGE AND SEWAGE TREATMENT

Cal., Dinuba—De Waard & Cobham, 207 Granger Bldg., San Wiego, awarded contract for sewage disposal works at $122,700. Contract includes reinf. conc. ejector pit and bldg., 40x40 ft.; 3 500-gal. ejectors; 2 compressors! two 30. h. p. motors; 2 air receivers; 4 reinf. conc. settling tanks and 2 sprinkler beds.

Cal., Englewood—Contract for 8-18 in. vit. clay pipe in Lateral Sewer Dist. No. 1, to D. S. Reid Constr. Co., Littleton, aat $87,632; 8-18 in. vit. clay pipe to Gordon Constr. Co., Barclay Bld., Denver, at $32,040.

Cal., Pasadena—De Waard & Coblan, 207 Granger Bldg., San Diego, awarded contract for constructing sewerage system in San Rafael Heights, 11,004 ft. 8-in., 4295 ft. 10-in., 1396 ft. 12-in and 1435 ft. 14-in. vit. pipe, etc., at $106,660.

Can., Santa Monica—J. Chutuk, 426 Bullard Bldg., Los Angeles, awarded contract for constr. of 58,000 ft. 12-in. conc sewers and 40,000 ft. cement curbs on Penn. Ave., at $65,048.

Cal., Watts—B. D. Baucus, 173 W. 43rd St., Los Angeles, awarded contract for sewerage system: 123,449 ft. 6-12 in. conc. pipe, at $484,000.

Ont., Hamilton—J. H. McKnight Constr. Co., Ltd., Toronto, awarded contract for constr. of Sec. No. 3, Western Storm overflow sewer, at $192,700.

Conn., Wethersfield—B. Silvestrd, 249 Otis St., Hartford, awarded contract for 5,000 ft. 24-in. tile sewer, 30,000 ft. various smaller sizes, tile sewers and one 35x70 ft. settling tank, at $200,000.

Ill., Rock Island—Frazier-Davis Constr. Co., Arcade Bldg., St. Louis, Mo., awarded contract for 14-24 in. vit. rile drains, at $49,000.

Ind., Indianapolis—Following contracts let by Bd. San. Commrs. for power plant equipt. and appurts. for disposal plant: 3 400 hp. water tube boilers, to Babcock & Wilcox Co., S. Dearborn St., Chicago, and 3 stokers to Green Eng. Co., East Chicago, Ind., total $45,990; 3 steam turbo blowers to Dravo-Doyle Co., 808 Merchants Bank Bldg., $53,348; 2 elec. generator units, 5 surf. condensers and one switchboard to General Elec. Co., Traction Terminal, at $66,601; mechanical equipt. for sludge remover to Link Belt Co., W. Mich. & Holmes St.s., $4818; 4 drilled wells, 80 ft. deep, to J. W. Henslet, 313 N. Capitol Ave., $2992.

Ia., Clinton—W. B. Carter, United Bank Bldg., Sioux City, awarded contract for constr. of san. sewers at $49,952; clay sewer pipe, 2000 ft. 30-in, 400 ft. 27-in., 800 ft. 24-in and 10,000 ft. 8-in.

Md., Baltimore—Ryan Constr. Co., Phila., awarded contract to construct storm water drain from East and Fairmont Ave. to Fayette and Third Sts., at $101,000.

Md., Towson—Thoncy Pietro & Co., Morgantown, W. Va., awarded contr. to construct sewerage system at $69,255; U. S. Engrg. Co., 205 W. Lombard St., Baltimore, contract to build disposal plant, at $34,210.

Neb., Omaha—Following contracts let for sewers: 16th Street to Connolly & Fitch, at $61,159; 28th St., to Omaha Constr. Co., at $6267; Happy Hollow Blvd., 11th to Charles, to H. J. Peterson Co., 403 Farnam Bldg., Omaha, at $9050; 33rd St., T to W Sts., to Gus Carlson, 4205 Pacific, Omaha, at $1876; Charles—49th to 51st—to Jno. S. Farrell, at $2190.

O., Toledo—Whitney Constr. Co., awarded contract for sewers in Sheridan Pl., at $45,279.

Pa., Johnstown—Contract for Sec. 4, Main Sewer—19th Ave. to Johns St., let to A. L. Anderson & Bros., Inc., Altoona Trust Bldg., Altoona, at $200,000; Sec. 5, Main Sewer, to M. O'Herron Co., Bigelow Blvd., Pittsbugh, at $113,493.

Pa., Phila.—Contracts awarded for sewer in Comley and Powell Sts., to A. Di Sandro & Sons, 3906 N. 5th St., $3830; 21st St. to E. Leva 3851 N. 10th St., $22,850; 66th Ave. N. to D. Peoples, 742 E. Penn. St., at $27,991; 52nd & Diamond Sts., to F. Joffola, 1203 Tree St., $8942; Montgomery & Lebanon Aves., to F. T. Buckins, 4050 Kensington Ave., $6218 and $9050, resepectively.

S. C., Florence—Chitwood & Palmer, awarded contract for storm drains and sewers at $68,455.

Tex., Amarillo—Gordon Constr. Co., Denver, Colo., awardede contr. to construct sewers, at $60,000.

Tex., Breckenridge—McKenzie Constr. Co., awarded contract for constructing sewer system; 12 miles piping $235,000 available.

Tex., Greenville—N. D. Duck, awarded contract to construct storm sewer system, at $59,824.

WATER SUPPLY AND PURIFICATION

Ark., Little Rock—Public Utilities Co., awarded contract to constr. water and light systems in Park Hill Addn., at $53,100.

Que., Montreal—Canadian Iron Foundries Co., Ltd., St. Maurice St., Three Rivers, Que., awarded contr. by City Council for cast iron pipe at $40,000; Canadian Westinghouse Co., Ltd., 285 Beaver Hall Hill, contr. for elec. equipt. for elec. pumping station, at $88,000.

B. C., Vancouver—Pacific Coast Dredging & Contracting Co., Ltd., 904 Standard Bank Bldg., Vancouver, awarded contarct for constr. of water storage dam at Anyox, by Branby Mining & Smelting Co., at approx. $350,000, for constr. of dam, while other incidentals such as constr. of temp. tramway to take in material, installation of pipe, penstocks and hydro-elec. machy. will involve total outlay of about $500,000.

Conn, Hartford—Chicago Bridge & Iron Works, 3119 Hudson Terminal, New York, awarded contract by Underwood Typewriter Co., for steeel pump house, water tower and tank at plant, at $30,000.

Ill., Joliet—D. R. Kuehn, Aurora, awarded contract for 4-6 in. cast iron mains, hydrants, valves, etc., in Herkimer St., at $40,000.

Ia., Edgewood—Contracts for 10,120 ft. 4-8 in. c. i. pipe, 3000 ft. 2-in. galvanized pipe, special

castings and 20 hydrants, to C. W. Rowland, Des Moines, at $11,421; 50,000-gal. steel tank and tower, pumping machy. and pump house to Pittsburgh-Des Moines Steel Co., 9th and Tuttle Sts., Des Moines, $44,017; well to J. E. Emery, Cedar Rapids, at $1,000.

La., New Orleans—Sewerage & Water Bd. let contracts for 2 water boilers, 599-1800 hp. capy., to Lasker Iron Wks., 3201 S. Lincoln St., Chicago, at $28,915; elec. equip. to Westinghouse Elec. & Mfg. Co., Union Bldg., Pitssburgh, at $20,575; two-36-in. centrif. pumps, 30,000,000 to 40,000,000-gal. daily capy. and 2 motors, to Delier Pump & Machinery Co., 165 Bway., New York, at $9,000.

Minn., Duluth—Peppard & Fulton, 217 Bd of Trade Bldg., Superior, awarded contract for Endion reservoir at $184,523.

N. Y., Brooklyn—N. B. Stefano, 257 Glenn Ave., Tompkinsville, awarded contract for mains in Flatbush Ave., Aves. T & U, Coleman and Hendrickson Sts., at $28,571; Manhattan and Green point Aves., to Carter Cont. Co., Inc., 582 78th St., at $48,167; Oceanview, Skillman, and 17th Aves., Barrett, Cleveland, Pine, W. 8th, E. 21st Sts., etc. to Paladino Contg. Co., 337 E. 120th St., New York, at $12,295.

N. Y., New York—Norton Eng. & Contg. Co., 51 W. 149th St., awarded contr. for mains in Brook, Jerome, Tremont and University Aves., E. 143rd, E. 177th and W. 177th Sts., at $116,729; C. Delblasio, 339 7th Ave., Mt. Vernon, awardede contract for mains in Buhre, Cranford, Cromwell, Manhattan and other streets in Bronx, at $18,115.

N. C., Raleigh—Contr. for extension and impvts. to water works, let as follows: Contr of impounding reservoir, area 116 acres, including dam to Va. Machy. & Mill Co., for $64,381; steel tower and tank to contain 600,000 gal. at $21,568 to R. D. Cole Mfg. Co.; found., for tower and tank, $4900. City will lay pipe line, purchasing own material total cost $115,676, including 4380 ft. 20-in., 6600 ft. 12-in., 15,468, 8-in., 12,050 ft. 6-in. and 3870 ft. 6-in. main to be replaced by larger main and used for further extension; add 50 fire hydrants; dam of new impounding reservoir of earth 30 ft. high with conc spillway, providing supply of 400,000,000-gal. covering 116 acres; present area 77 acres and 150,000,000 gal supply; addition to equipt. to cost in all $215,619 giving complete supply to all parts of City. rFuther development of pumping sta. filter houses etc. to be considered later. E. B. Bain, Supt. in charge of main exten.

O., Cleveland—Peter F. Connell, Kent. O., awarded contract for laying steel water mains from Kirkland Pumping Sta. to new water wks. reservoir on Baldwin Rd., at $510,670.

O., Cleveland—Rice & Jones Co., 1836 Euclid Ave., awarded contr. for 18x24 ft. brk. pumping station, at $4980; 6530 ft. mains to Lannahan Constr. Co., Marshall Bldg., at $22,222; 14,650 ft. mains to D. Pfahl &Co., Guardian Bldg., at $69,761.

S. C., Walhalla—Henry Constr. Co., Greenville, S. C., awarded contr. for water plant; conc., at $125,000.

Wn., Seattle—Grant Smith & Co., Henry Bldg., awarded contract for installation of an all steel pipe line from Molasses Creek to Volunteer Park Reservoir—a trifle over 14 miles. Work involves everything buck backfilling. Contr. price $1,468,-602.50.

Wn., Walla Walla—Pacific Coast Paving Co., Perking Bldg., Tacoma, awarded contract for constr. of twin reservoir at $176,841.

Prospective Work

ROADS AND STREETS

Cal., San Bernardino—Bids will soon be asked for constr. of Deep Creek cut-off—about 15 miles—to be built jointly by state and Federal Govt., $105,000 voted by state wor work; balance will be from Fed. funds. Work will be under joint supervision of Co. Surv. E. T. Ham and C. H. Sweetser, Dist. Engr. Bureau Pub. Rds., U. S. Dept. of Agriculture.

Cal., Santa Rosa—Hwy. Comn., will construct entirely new rd. over St. Helena mountain betw. Napa and Lake Cos. Comn. has $180,000 in budget for work. N. D. Darlington, Chrmn. of Comn.

Colo., Denver—Springs-Limon Road will be completed this summer at cost of $76,000. It is also reported that 1.4 mi. conc paving will be built on road betw. Littleton and Sedalia. Another proj. statement on same hwy., not yet approved, has been received. Cost will be abt. $46,000, the Government to pay usual share.

Fla., Jacksonville—Ests. of cost for pacing 4 streets in Riverside submitted to City Comn. by City Engr. sheddan. Paving estimates $77,665; sewers, $34,000.

Ga., Brunswick—Board of Commrs., Glynn Co., appropriated $75,000 for completion of Broadfield Rd. leading from Buffalo Swamp on Jacksonville Hwy., road will also be completed at once. Approx. $150,000 will be expended on impvts. to ihghways within next few months.

Ill., Moline—Council adopted Ords., providing for impvts., costing approx. $85,073. Largest of the impvts. is the 21st Ave. paving dist. Est. cost $57,820. 11th Ave—C from 27th to 22nd St.; 29th 11th Ave. C to 12th Ave. will be paved with concrete. Est. $20,995; alley bet. 15th and 15th A., from 21st to 23rd, conc. pavement. Est. $2611; alley betw. 14th and 15th Aves., from 26th to 27th Sts., conc. pavement, $2297. Sewe rand water main on 20th St.—19th Ave. 1 blk. so. $1350.

Ia., West Union—Resolution adopted by City officials to lay 40 blks. of paving during summer months. H. R. Green, Engr. Cedar Rapids, will prepare plans. Est. cost $140,000 for the paving.

La., Baton Rouge—City Comn., will expend about $639,788 to hard-surface or gravel 23 miles unimproved streets; $66,548 for 96,500 ft. sub-surface draining. Jno. J. Mundinger, Engr.

La., Monroe—City will pave 5 miles of streets. Est. cost of construction, $300,000, or $60,000 per mile, as a full-width city pavement will be built.

La., New Orleans—State Hwy. Dept. plans 55 mi. rdway betw. New Orleans and Hammond, including dredging swamp in vicinity of Pontchatoula; also 8 ft. canal from 40-50 ft. wide from Pontchatoula to La Branche. Cost $7,000,000. Work will start within 60 days and it is estimated it will take 3 yrs. to complete same. J. M. Fourney, St. Hwy. Engr.

Md., Baltimore—State Roads Comn., 601 Garrett Bldg., will expend $4,800,000 to improve state highways; $3,000,000, including Fed. and State Aid, etc.; $1,800,000 for new constr. including Baltimore Southern Maryland Hwy.

Md., Frostburg—$50,000 bonds voted here for strfeet impvts. It is conservatively estimated that over $300,000 will he expended on street, sewer and personal property impvts. within next 24 months.

Mich., Detroit—City Council voted to allow appropriation in budget of Dept. Pub. Wks. of $1,200,-000 for resurfacing and widening 3 streets.

Minn., Thf. River Falls—Petition of Bd of Commrs. Beltrami Co., asking permission to construct rd. across Red Lake Indian Reservation, has been granted by Dept. of Interior.

Minn., Winnebago—Bids will be asked aht. June 1st for 8 blks. paving. Bids will be asked on various types. Cons. Engr. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul. R. L. McMillen, Vil. Clk.

Miss., Pascagoula—Jackson Co. bd. of Supvrs. and Miss. State Hwy. Comn., Meridian, will expend abt. $387,000 to construct perm. hwy. across county; $95,000 for Dist. 2 with Moss Point principal City; $112,000 for Dist. 3, including Pascagoula; $180,000 for Dist. 4, with Ocean Springs included. Fed. Aid assured.

Mo., Monticello—St. Hwy. Dept. Jefferson City, will constr. 7.94 miles .state road northward and southward through La Grange Special Rd. Dist.; grade, constr. draing. structs; 16-ft. wide gravel pavement or gravel surface course on stone base course, etc.; Lewis Co. Fed. Aid. Proj. 39; consturct 8.37 mi. state road from Canton southward and westward; grade, construct draing. structs; 16-ft. wide gravel pavement or gravel surf. on stone base course, etc., Lewis Co., Fed. Aid. Proj. 38. M. J. Hanick, Div. Engr., Howe Bldg., Macon, Mo.

Mo., St. Louis—City Council will soon ask bids for 1st of City's program of street and alley reconstruction and resurfacing. Work will cover about 32½ miles and total est. cost is $2,580,000.

O., Cleveland—State, County and local funds will

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Brnces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Damping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

be combined in financing road program in Cuyahoga County. Est. cost of program is $2,500,000 for 85 paving new paving. This will include 40 roads.

O., Marysville—Commrs. have granted petitions for impvt. of sects. of 13 roads in Union Co.—total of 60 miles—at est. cost of $150,000.

Ore., Portland—U. S. Forest Service will build 500 mi. of road costing $281,000 this year in Oregon; 434 mi. of trail, $64,000 & 4 bridges costing $2600. In addn., there will be $26,000 for maintenance of trails and $36,000 for maint. of roads. F. H. Brundage, Forest Inspector. Total allotment for the 14th forests in state amounts to $415,000, with $66,000 additional from counties.

N. J., Newark—Specfs. prepared by Co. Engr. Stickel for road improvements—6 roads and 2 small bridges. Est. total cost $600,000. Specfs, will be submitted to St. Hwy. Comn. for approval. Co. Purchasing Agt. Bergen will advertise for bids as soon as approval is granted.

N. Y., Oneida—A 16-ft. conc. hwy. will be built this summer along gorge route 4½ miles so. from Chittenango toward Cihittenango Falls and Cazenovia. Est. cost $166,000.

N. Y., Troy—Total appropriation of $144,898 for hwy. constr. in Washington Co. authorized by Bd of Supvrc., at Hudson Falls. $76,000 allotted for hwy. units from Whitehall to Dresden Centre and from Whitehall to Dresden Sta. Total cost of this proj. $25,000. $6858 allotted for strip of hwy. in village of Greenwich. Third proj., involving constr. of hwy. from Hartford town line to Kingsbury town line—5 miles—authorized at expendt. of $62,400. Total cost of this link will be $206,800.

N. C., Asheville—Mount Mitchell Development Co. plans expendt. of $100,000 to develop Mt. Mitchell motor road .

N. C., Hamlet—$75,000 additional for street paving program voted by Bd. of Aldermen. Bonds will be issued as soon as possible. This brings total paving program up to 50,000 sq. yds.

Pa., Hastings—Co. Commrs. notified by St. Hwy. Dept. that plans are being prepared for reconstr. of Sec. 1, Route 21, connecting Patton and Hastings. J. L. Herber, Engr. for 11th Dist. asked Commrs. for approval of use of 3-in. or 4-in brk. for paving rd. and approval has been given. Bids will also be asked for bldg. Sect. 2, Route 62, Spangler & E. Carroll Twp. section.

S. D., Aberdeen—Brown County will construct 19 mile hwy. from Hecla to Frederick. G. A. Peppers Aud.

S. D., Yankton—Commrs. Yankton Co. decided ot construct roads 9, 18, 19,—17 miles. H. H. Corbin, Co. Hwy. Engr., J. D. McCoun, Aud.

Tenn., Nashville—State Hwy. Comn., Nashville, will constr. 6 mi. bitum. macadam rd. from Mascot to Grainger Co. line at cost of $600,000; Knox Co., FAP.; 13.91 mi. chert rd.—Lexington to Madison Co. line, $278,800; Henderson Co., F. A. P.; 20 mi. bitum. mac. rd. from Memphis to Fayette Co. line, at $600,000, Shelby Co. FAP; 5.27 mi. bitum conc.—Nashville city limits to Harding pike, $585,000; Davidson Co. FAP; 9 mi. bitum rd. from Pikeville to Rhea Co. line, $330,000; Bledsoe Co. FAP; 2.23 mi. gravel rd. from Barren Plains to Keysling Rd., $12,000; Robertson Co., FAP; 12 mi. bitum. macadam rd. from Madison Co., to Carroll Co. line ;$360,000, Gibson Co. FAP; 7.90 mi. bitum. macadam rd. Untion City to Terrell, $237,000, Omion Co. FAP; 16.05 mi. bitum. macadam rd.—Waverly to Dickson Co. line, $400,000, Humphreys Co., FAP; 31 mi. bitum. macadam rd.—Washington Co. to Hawkins Co. line, $850,000, Green Co., FAP; 1.76 mi. bitum. macadam rd.—Huntingdon to McKenzie, $382,000, Carroll Co., FAP; 15 miles bitum mac. rd. from Kingston to London Co. line, $450,000, Roane Co. FAP; 37 mi. bitum. mac. rd. from Mont Eagle to Warren Co. line, $1,000,000; Grundy Co. FAP; 10.60 mi. bitum. macadam—Davidson Co line to Dickson Co. line; $365,000, Cheathem Co. FAP; 5.50 mi. conc. rd. from Sta. 102 to Forks-Duck Cry., $250,000; Hamilton Co. FAP; 22 mi. bitum. macadam rd. from Dandridge to Knox Co. line; $600,000, Jefferson Co. FAP; 3.50 mi. bitum. macad. rd. from Milligan College to Unicoi Co. line, $87,500.

Tex., Edinburg—$1,250,000 bonds voted by Hidalgo Co. for constr. of 2 conc. paved highways across county. Geo. P Brown, Co. Judge, Edinburg; P. S. Devine, Co. Engr., Pharr, Tex.

Tex., Kerrville—Chf. Engr., U. S. Bureau Pub. Rds., Washington, D. C., has approved plans to construct 13.9 miles gravel rd. on St. Hwy. No. 27—Kerr Co. line to Ingram; $107,136; 6.7 mi. 16-ft. gravel rd. on State Hwy. 27 bet. Kerrville and Ingram, $48,000; also 11.05 mi., 16-ft. gravel rd. on St. Hwy. 27 betw. Ingram and Mtn. Home, $180,000. Lee Wallace, Co. Judge, Kerrville; W. E. Simpson, Co. Engr. 414 National Bank Bldg., San Antonia, Tex.

Tex., San Benito—Specfs. for hard surfaced hwy. thruogh Hidalgo Co., being prepared by Pat Devie, Co. Engr. Bids may be asked on 3 types of paving. Constr. will be financed by proceeds from a $1,250,000 bond issue recently voted.

Utah, Salt L. City—State plans to expend $5,000,000 on road work this year. There are already under contract 8 projects. Of these Fed Govt. is bearing $1,098,004.22 of the cost. On projects where contracts are not yet let, fed. aid program, approver Mch. 20, contemplates apportioning $2,253,659 of fed. aid. Both this latter figure and money allotted to projects under contract, include only fed. aid, and not portion raised by county or state. New projects contemplated in program, in addition to contracst already let, are as follows: Magna to Tooele, $160,685; Morgan to Peterson, $45,000; Brigham to Corinne, $116,550; Woodruff to Wyoming, $33,000; Pigeon Hollow to Juab, $70,000; Richfield North, $70,000; Castlegate to Emery, $60,000; Summit Co., $30,000 and Heber to Summit, $50,000. In hard surf. constr., rough estimates place mileage on which construction is to begin this yr. at 51 mi. Tentative ests., place mileage of dirt roads, on which constr. is to be done this yr., at 132 miles.

Va., Richmond—State Hwy. Comn., sets aside $300,000 for Lee Hall-Toano Rd., known as Route 9. Allocations of new work for year, amounting to $5,105,000 announced. In addn., $210,000 in work under allocations made in 1921, will be carried on, making total authorized for year $5,315,000.

Wn., Walla Walla—Town contemplates expending approx. $90,557 if entire paving program is approved. Work of compiling ests. on various projects has been completed. Largest district is that of Chestnut St. which will cost approx. $50,000. Abt. 1 mi. paving, grading and curbing will be needed on this street.

W. Va., Fairmont—$391,000 bonds voted at recent election for paving in First and Second Wards in City.

Wis., Oshkosh—City and Winnebago County will expend approx. $2,000,000 for public impvts. this year. City will expend approx. $100,000 for paving 9 streets (mostly with Asphalt); 2 streets with surf. of oil macadam and still another street with Tarvia X penetration; also new sewers in 5 streets and in addition a large amount will be spent to replace or repair old sewers, etc.

SEWERAGE AND SEWAGE TREATMENT

Cal., Burbank—Trustees have declared their intentions to call elec. for June 20 to vote on $100,000 bond issue for purpose of constructing san. system, including pipe line, sewage treat. plant, conduits, etc. in Municipal Impvt. Dist. No. 1.. F. C. Miller, City Engr.

Cal., Pasadena—$412,000 bonds voted here for constr. of sewage treatment and disposal system.

Cal., San Luis Obispo—Council contemplates extending city's sewage system at cost of $17,000, and to construct new septic tank for sewer farm to cost approx. $15,000. Culvts. costing $6000 are also named as necessary impvt.

Cal., Santa Ana—Proposal to install addn. fall sewer system to be constructed jointly by Santa Ana and Anaheim, voted on favorably. Anaheim's proportion. $240,000 and Santa Ana's, $321,000. Comb. cost of treating plant and outfall line to ocean will be $252,000. For constructing sewer mains Anaheim voted $160,000 and Santa Ana, $149,000.

Ill., Chicago—Plans being made for sewers in various streets here. Est. cost $230,000. C. D. Hill, City Hall Engr.

Ill., Niles—City preparing plans for bldg. sewers and water works. Est. cost $40,000. Consoer Engineering Co., 140 S. Dearborn St., Chicago, Ill.

Ind., Hammond—Bd. Pub. Wks. contemplates expending $500,000 for main sewer on South Side and $900,000 for main sewer on North Side. Engrs. A. J. Swanson & W. F. Briggs, City Hall.

Ia., Boone—Plans and ests. approved for sewage

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

disp. plant for which bond elec. will soon be called. Est. cost $71,000. Burns & McDonnell, Cons. Engrs., Kans. City, Mo.

Kans., Wilson—W. B. Rollins, City Engr., has submitted report on prelim. survey of City for san. sewer and draing. purposes. Est. cost of complete sewer system $47,000.

La., Baton Rouge—City Comm. plans to construct 109,250 ft., (about 20 miles) sewer extension. $122,038. Jno. J. Mundiger, City Engr.

La., Haynesville—$85,000 bonds voted for disposal plant and sewer construction.

Mich., Royal Oak—Voters have approved propositions to bond City for $300,000 for construction of sanitary sewerage system and disposal plant.

Mo., St. Joseph—Resolution designating manner in which $795,000 bond issue for main sewers, is to be used, passed at special meeting of Council.

N. J., Haddon Heights—Will soon ask bids for 4 miles conc. and brk. sewers in various streets. Est. cost $30,000. B. Franklin Co., Crozier Bldg., Phila., Engrs.

N. Y., East Aurora—$77,000 bonds voted for additions to sewerage system. F. H. Ball, Pres.

N. Y., Manchester—Mayor Geo. E. Trudel anxious to start work immediately on proposed million dollar storm sewer project.

N. Y., Schenectady—$100,000 bonds voted for san. sewer in Erie Blvd. and extending storm sewer sys. in other streets. G. Howard, City Engr.

N. C., Elizabeth City—City having survey made by J. B. McCrary, Engr. Co., Atlanta, Ga., for impvts. to sewer system.

N. C., Leaksville—City will construct sewer cost at cost of about $110,000. J. W. Webb and E. W. Cole., Civ. & Cons. Engrs.

O., Cleveland—Co. Commrs. promise relief in sewer situation in Parma Twp., comprising 132 streets. Residents in 32 allotments desire sewers and other sanitary arrangements.

Ore., Pendleton—Bond Ord., for issuance of $85,000 of money recently voted by citizens for septic tank sewer system, authorized by Council. Est. submitted by Barr & Cunningham, Engrs., call for total expendt. of $69,919. Real est. on which proj. will be constructed will cost $20,000.

Pa., Harrisburg—Permits for more than a score of water and drainage impvts. issued by St. Dept. of Health. They include sewerage plants for Johnstown, Lock Haven, Monessen, Monongahela, New Castle, Freedam, Midland, Muncy and Corry.

Pa., Phila.—City will soon ask bids for 9½ miles sewers at cost of $180,000. J. A. Vogelson, City Hall, Engr.

Pa., Pittsburgh—Ord. given two readings, and expected to be passed at next meeting by Council, for issuance of $143,000 bonds for sewers and impvts. in McKeesport streets.

S. C., Ware Shoals—Ware Shoals Mfg. Co. will install sewer system for 100 homes, to be erected.

Va., Portsmouth—Having plans prepared for sewers in Park View, $32,885, Randolph St., trunk sewer, $148,000, Glasgow St. trunk sewer, $150,000. $360,000 bonds will be issued for work. J. F. Weaver, Jr., 404 Court St., Engr.

Wis., Birchwood—$40,000 bonds voted for sewer system.

WATER SUPPLY AND PURIFICATION

Ark., Conway—City will issue $150,000 bonds for impvt. and enlargement of water system. E. V. Leverett, Supt.

Ark., Piggott—Chamber of Comn. has unanimously endorsed plans of Comn., for water works, sewerage and light system for Piggott. Est. cost, $125,000. There will be about 9½ mi. water main, equal amt. of sewerage pipe and about 10 mi. light wire. Bonds will be issued immediately.

Cal., Alameda—Nine municipalities in Alameda County have agreed to organize into municipal utility district for purpose of acquiring water supply; possibly other utilities such as light, power and transportation.

Cal., Pasadena—$175,000 bond issue for water storage and distribution sys., carried at special election.

Ont., Essex—Plans being prepared for reservoir with 500,000 imp. gal. capy., elec. operated domestic pump 150 gal. per min. reserve pump 750 gal. per min. to be operated by high speed gasoline eng.; also new pumphouse. $40,000. Prices desired on all materials. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs.

Ont., Port Credit—Contemplate 4 miles cast iron mains, 1,000 ft. steel intake, pumphouse, centrif. pumps, water tank, $120,000. Gore, Nasmith & Storrie, Confederation Life Bldg., Toronto, Engrs.

Ont., Smith's Falls—Provincial Health Dept. insists on installation of filtr. plant, in connection with water works system.

Ida., Idaho Falls—Plans for new pumping station, filtr. plant and other water works impvts., presented and approved. Bond election for $250,000 will be called last week in May. Burns & McDonnell, Cons. Engrs., Kans. City, Mo.

Ill., Jacksonville—Making plans for 4-6 in. mains. Est. cost $30,000. Caldwell Eng. Co., City Hall, Engrs.

Ill., Sheffield—Town considering constr. of water supply system. Engineer not selected. B. W. Borden, Pres.

Ia., Haynesville—$45,000 2bonds voted for water main extension.

Me., So. Portland (Portland P. O.)—Portland Water Dist. having prelim. plans made for extending water system here. Est. cost $100,000. L. Metcalf, 14 Beacon St., Boston, Engr.

Mo., Kansas City—$11,000 bonds voted here for water works impvts.

Mo., St. Louis—City considering installing one 20,000-gal. crank and fly-wheel type triple expansion pumping engine with vacuum pump, boiler, feed and air compressor, etc., $75,000.

Mo., Trenton—Plans and ests. for water works impvts., including filtr. and other impvts. presented and approved. Bond elec. $150,000 soon. Burns & McDonnell, Cons. Engrs., Interstate Bldg., Kans. City, Mo.

N. Y., Gouverneur—Plans being made for new water supply system; $50,000 to $75,000. $3,000 voted to drill test wells.

N. Y., Locust Valley—Plans 18 miles mains with pumping station, Tanks, etc. $330,000. S. B. Bowne, Mineola, Engr.

N. Y., Schenectady—Bd. Pub. Wks., making plans to replace 36-in. main from here to pumping station at Rotterdam, at $150,000. G. Howard, City Engr.

N. Y., Troy—Ord. authorizing Comptroller to pay for cost of extending water mains in city adopted unanimously. Cost $70,000.

N. C., Kinston—City will develop additional water supply; install 2½ miles 10-in. cast iron pipe, drill 2 or 3 wells, install pump, etc. Wm. C. Olsen, Cons. Engr.

N. C., Leaksville—City will construct water system at cost of about $125,000. J. W. Webb, E. W. Cole, Civil & Constr. Engrs., Salisbury, N. C.

N. C., Morgantown—Town will install gravity system of water works. About 12 mi. pipe line and dam; 10,000,000 gals. daily capy. Est. cost $200,000. O. B. Lackey, Mgr.

Okla., Beggs—$50,000 water works bonds voted.

Okla., Henryetta—$45,000 bonds voted here for extension of water works system.

Tenn., Memphis—City will construct water works; erect pumping sta. and filter bldg., capy. 20,000 gals. daily; conc. covered reservoir, 11,000,000 gals. daily, cast iron pipe line, $300,000; install boilers, crank and fly-wheel pumping engine, air compressors, turbine, centrif. pumps, cooling towers, ponds and spray nozzles, traveling cranes, coal-handling equip. Amt. to be extended $2,000,000. Constr. bids opened probably in September; machinery bids in June. Fuller & McClintock, Engrs., 421 Produce Exch. Bldg., Kans. City, Mo.

Tex., Kerrville—Phelps & Dewees, Archts., Gunter Bldg., San Antonio, Tex., preparing plans for sewer, sewage disposal plant and water softening plant for American Legion Sanatorium. S. B. Cowell, Chrmn. Bldg. Comn. Will invite competitive bids.

Tex., Ft. Stockton—Prelim. surveys and estimates made for complete water works. $75,000. Berrell-Bartlett, Calcasieu Bldg., San Antonio, Tex., Engrs.

Tex., Waxahachie—$37,000 water and sewer bonds sold and new deep well will be drilled. Water Comm. will select location for well. Hole will be sunk to Trinity sand.

W. Va., Wheeling—$2,000,000 bonds voted here for filtration system.

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Harris Air Pump Company.
Midwest Engine Co.
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Good Roads Machinery Co., Inc.

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Austin-Western Road Machinery Co., The
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Good Roads Machinery Co., Inc.
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Sauerman Bros.

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Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

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Truscon Steel Co.

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Kolesch & Co.
Lufkin Rule Co., The

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Austin-Western Road Machinery Co., The

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Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
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Good Roads Machinery Co., Inc.
Littleford Bros.

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Austin-Western Road Machinery Co., The

Street Paving Material.
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Tarvia.
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Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines.
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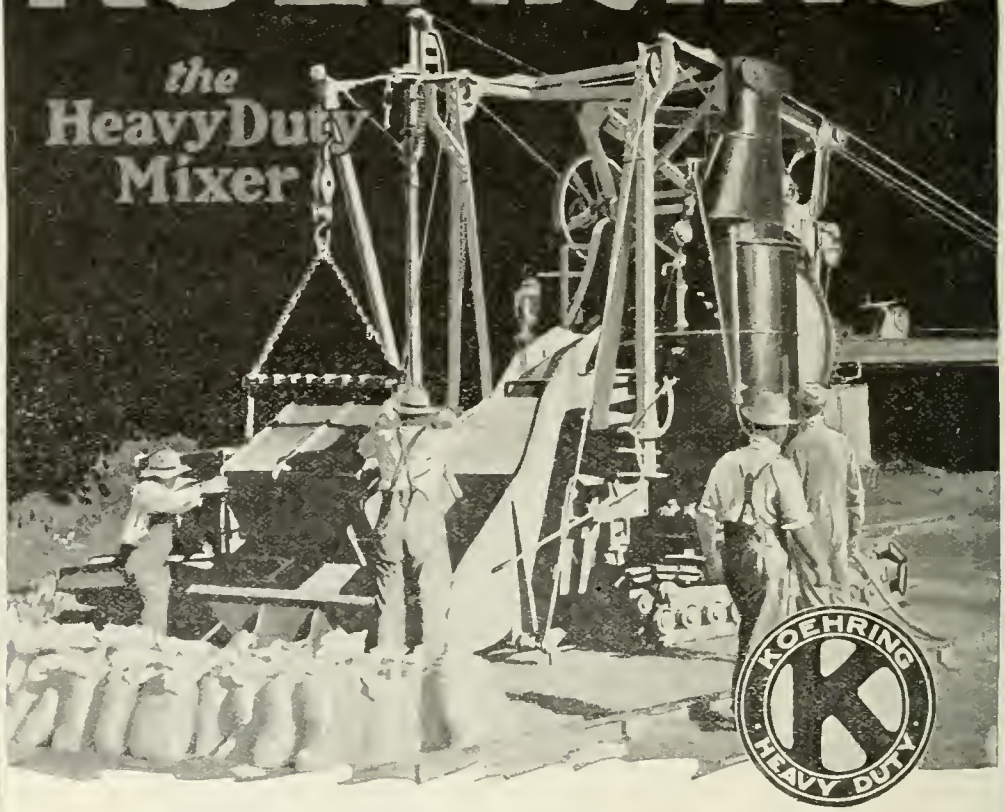

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Vol. LXII JUNE, 1922 No. 6

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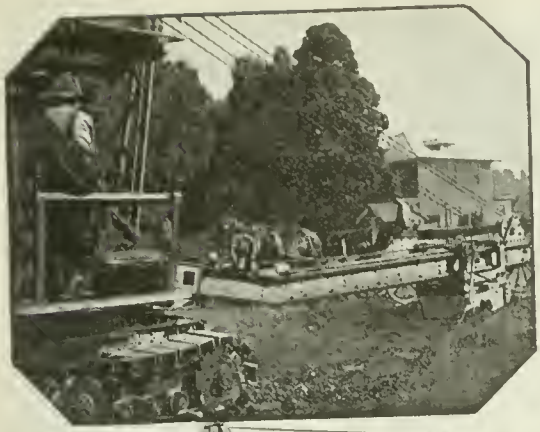

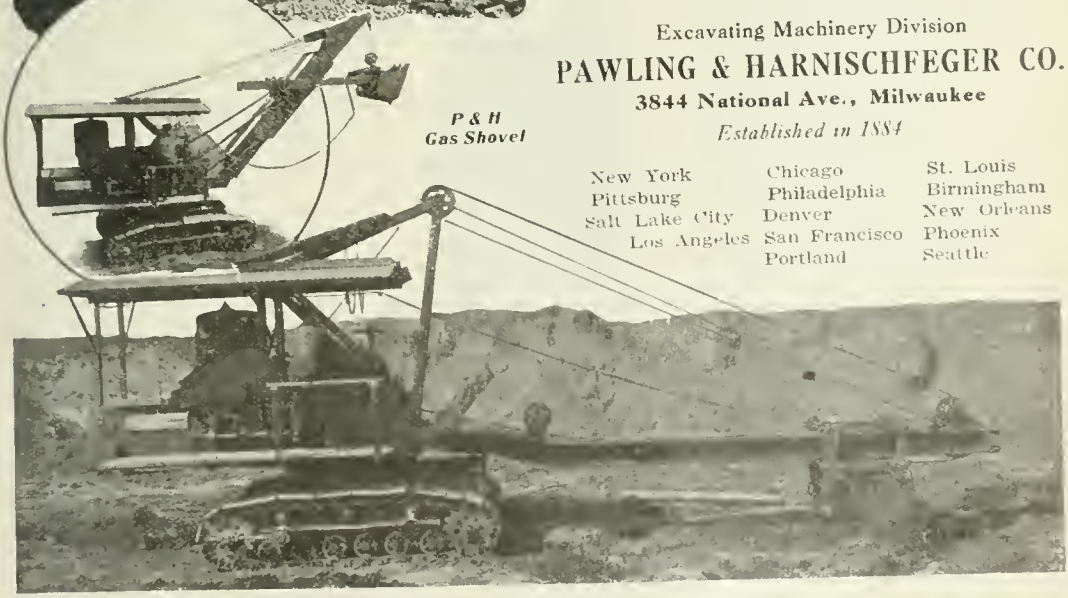

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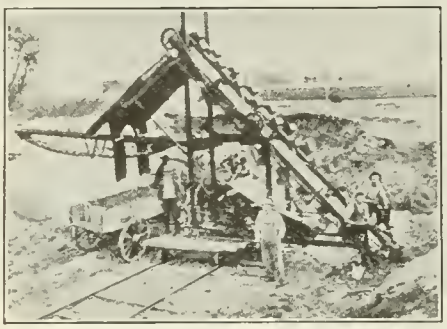

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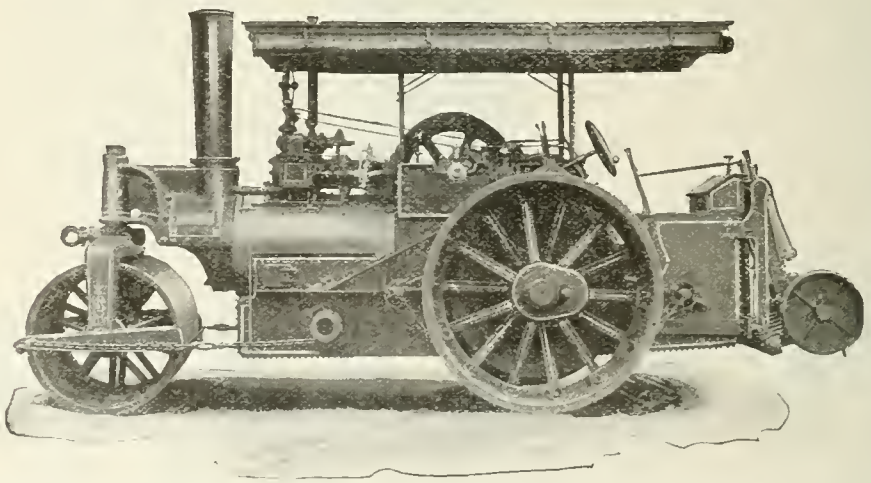

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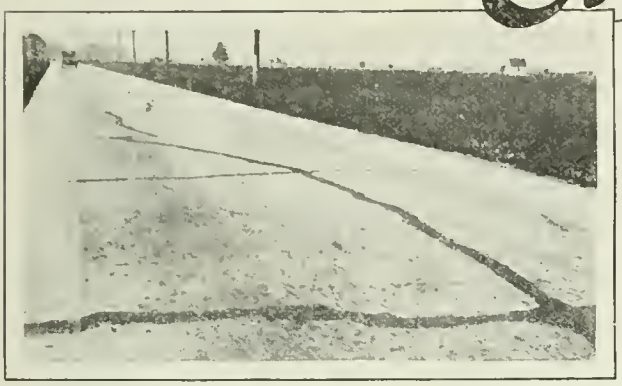

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4-22

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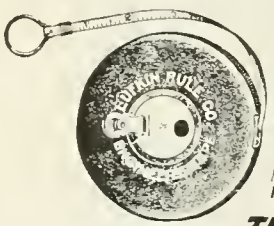

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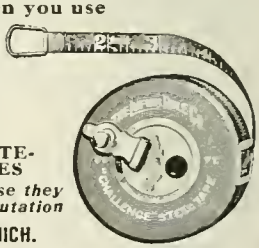

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Within the past year, the first of these disadvantages was removed through the production of a du Pont Straight Dynamite which functions with normal efficiency at 10° below zero.

Both disadvantages have now been removed in Dumorite—a guncotton-nitroglycerin dynamite, which is not only absolutely non-freezing but is the first dynamite with nitro-glycerin content which will not cause headaches.

Under ordinary conditions, Dumorite does approximately the same work as 40% dynamite stick for stick. And you can buy 135 to 140 sticks of Dumorite at the same price as 100 sticks of "40%." Dumorite is saving money today for operators in most kinds of blasting work. If it is adapted to your work, your dynamite dollar will be worth $1.35.

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WRITE FOR OUR PRICES

Motor Truck Operation and Accounting—82

THE HIGHWAY TRANSPORT CLEARING HOUSE

By Tom Snyder, Transportation Building, Indianapolis, Ind.

(Editor's Note: Following is the progress report of the committee of which Mr. Snyder is Chairman as presented at the meeting of the National Highway Traffic Association held in New York City on May 12, 1922.)

Let us determine first just what is meant by the term "Highway Transport Clearing House."

In analyzing the service of Inter-City Motor Express from 12 industrial centers in the United States, many stages of development in the method of soliciting, collecting and clearing freight for motor transport are found.

The process of development is about as follows:

First—The individual operator, who operates one or more trucks, picks up all shipments at shippers' platform, delivering direct to consignee, securing his business through personal solicitation of shipper and consignee.

Second—The individual operator who uses his garage or provides an especially arranged terminal requiring shippers to bring all shipments to such building from which he delivers direct to consignees over one or more highways, securing his business by a personal solicitation of consignees along the route over which he operates, offering store door delivery free for an order by the consignee upon the shipper to ship all orders via his truck line.

Third—A group of operators who render service over different highways and who jointly employ one or more freight solicitors who solicit business from shippers and consignees at terminal ends and intermediate points.

Fourth—The most definite and most successful application of motor transport is found where such groups have also provided station buildings at terminal ends and at intermediate points.

Let us agree then that a highway transport clearing house is an established station from which highway transport shipments can be cleared from the shipper to the transportation trucks, operating over any or all highways over which transportation service is being rendered. That it is a centralizing station to which jobbers, manufacturers, merchants and every variety of shipper can bring his consignments, big or little, and from which station, Rural Motor Express Trucks, Inter-City Motor Express Trucks, Highway Transport Trucks, load and depart according to route schedules, or special service arrangements and it is also a station to which agricultural products, eggs, poultry, butter, cream and other commodities can be consigned by farmers and cleared to consignees, be they individual citizen, merchant, jobber or manufacturer.

The service of a motor transport clearing house will be to meet the fluctuating demand for motor transport, to fix rates, determine classfications, maintain schedules and to educate the shipper, the consignee, and the general public as to the advantages of this type of transportation.

A few years ago the "Highway Transport Clearing House" was considered a possible future development in highway transportation. Today it is seen by all those who try to apply dependable motor transport service, as an absolute necessity.

It can be safely said that Inter-City Motor Express, or Rural Motor Express cannot be generally and successfully applied except through the service of a motor transport clearing house.

The successful operation of one, two or three trucks from some shipping center out to some rural community or to a number of small towns, is but one step in the experimental stage, and is not sufficient evidence of the applicability of motor transport as a definite system of transportation.

The big question coming from the shipper, the consignee, the public and the railways today is, can the highway and the motor truck take the short haul L. C. L. freight off the hands of the railways?

Even if the answer is yes, with the provision that time for its proper development must be allowed, it immediately suggests system, uniform methods, and crystalization. We cannot build confidence, nor can we hold confidence already developed by telling the shipper that he can have motor transport service over the Jackson highway, but not over the

Lincoln highway, that the carrier rate over the Jackson highway is 2 cts. per 100 lbs. per mile on first-class, with a varying rate for lower classifications, while the carrier rate over the Great Lakes highway is 1½ cts. per 100 lbs. per mile, with no classifications, that there is no store-door delivery charge on shipments over the Bingo highway, but that such a service fee is collected on shipments over the Johnson highway.

We can no longer satisfy the shipper or consignee with the fact that truck operator Jones, who, though he is responsible financially for the goods turned over to him, also carries a dependable cargo insurance policy, while operator Smith is not responsible and is also without insurance, but that Smith hauls for a lower rate than Jones.

The greatest need in the development of motor transport as a dependable transportation service out of all American Industrial centers is the establishment of motor transport terminals and clearing houses.

Splendid service is being rendered between many cities throughout America, and this, often, where the keenest kind of steel rail competition exists, while many rural communities in great need of motor transport service, are not served.

Many routes have been established between communities where steel rail service is far below the transportation demands, but much of the service now being rendered, good or bad, is but blind adventure.

Classifications as established by the common carriers are rarely observed by the motor transport systems, the non-observance of such classfications already established being the cause of the failure in many transport adventures.

These and many other barriers to the practical application and industrial economy of motor transport could be quickly overcome through a motor transport clearing house.

A clearing house is a centralizing point of activity where ideas and methods can be cleared as well as tonnage, and highways transport is now waiting the stabilizing influence of uniform and dependable methods.

Clearing houses and the clearing house system in all freight clearing centers are of constantly increasing importance, and as time and economy in clearing shipments are being recognized as the major portion of the transportation problem, the motor transport terminal comes rapidly to the foreground as a tremendous factor in the entire scheme of transportation.

The major portion of all shipments are consigned to a place, and not to the consignee, and though the consignee may be a farmer or a rural merchant, within a few miles of the freight terminal, and though this distance may be but a fraction of the transportation distance, it is very often the most expensive leg of the service, both in time and money because a very definite interruption takes place when consignment reaches the terminal, at nearest point to destination.

This interruption takes place because the rail or motor service feels that its responsibility ends at its terminal and the consignee is expected to complete the transportation service, with the result that terminal congestion, embargoes and delays are adding millions to the cost of transportation.

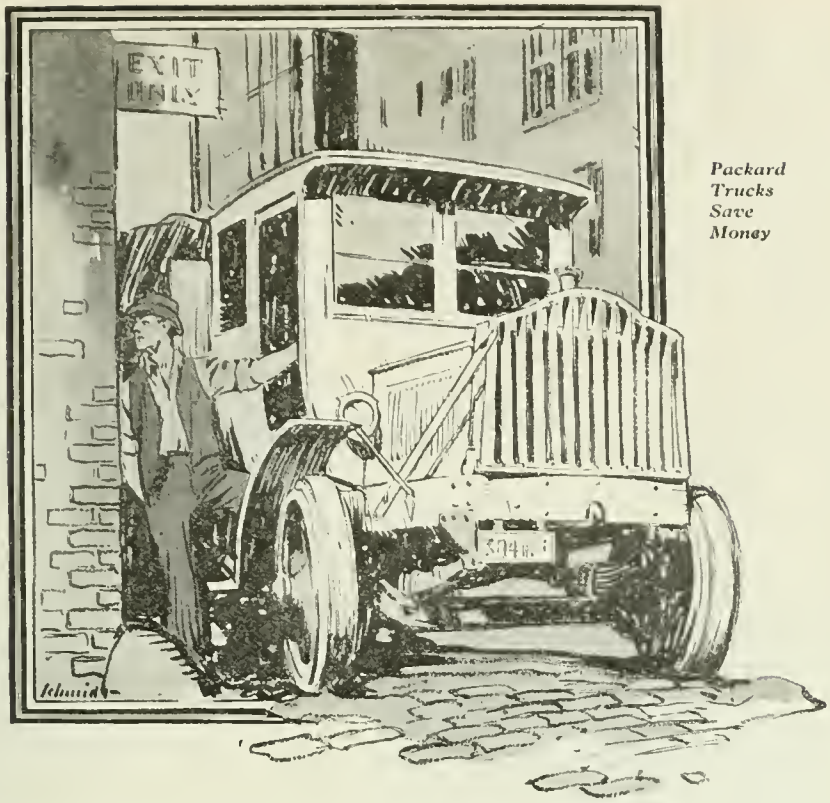
Store-door delivery is now being considered by many of America's largest shippers as a means of providing a continuous transportation service from shipper to consignee, and to provide that the service be extended to all consignees within motor distance or rail or water-way terminals.

Store-door delivery as a relief to terminal congestion, and its many kindred evils immediately involves the application of highway transport as the service could profitably and practically be extended to consignee 40 or 50 miles away from terminal and to farther points if no rail service is available.

With the adoption of store-door delivery service, motor transport clearing houses would become an absolute necessity, and with the establishment of motor transport clearing houses, the conecting link between all methods of transportation would be quickly welded.

The pick-up at shipper's platform methods, makes motor transport a random service, and subjects the truck operator to many delays due to shipments not being ready when he reaches shipper's platform, as truck operator has no control over shipping departments, and as limited platform space may cost him many delays, he has no chance of fixing schedules for reaching shipper.

The pick-up at platform method prevents operators from loading consignments to truck and provides for an unloading order as his last consignment picked up might be consigned to the last stop on his route, or the reverse.



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PACKARD TRUCKS

The theory that all shipments to be transported by motor truck can be picked up at the shipper's platform by the transport truck, and that the highway transport truck can also deliver to store door, or be successfully applied as a cartage vehicle, must be given up.

This statement may excite considerable opposition, because so much has been said and written about the motor truck rendering a service direct from shipper to consignee and that because of such service unnecessary handling of freight has been saved.

I know of no important industrial center in America from which (within the next six years), less than 8 different motor transport routes will be operated and from some centers this number may be increased to from 20 to 30.

It would be a daily occurrence for some shippers to have consignments for each of these routes, and limited platform space would prevent the transport truck from each of these routes, picking up their route consignments.

Many shippers have said that they would gladly use motor transport for all short haul consignments if their shipping departments could load motor transport consignments to their own freight delivering vehicles, to be dropped off at a motor transport terminal while making daily deliveries to all other terminals.

As evidence of the need and constructive advantages of motor transport clearing houses, Indianapolis no doubt offers the best illustration in America.

Motor transport routes have been operated out of Indianapolis for the past 8 years and up to the summer of 1921, 9 operators out of 10 went down in failure and defeat.

Indianapolis has 7 steam and 12 electric traction lines radiating from it in all directions, and the successful application of motor transport with such competition requires system.

In 1920, a clearing house system was organized and began the work of standardizing motor transport, fixing routes, establishing schedules, fixing rates, adopting a uniform bill of lading and freight receipt, with the result that commencing April 15, 1922, 10 definite Inter-City Motor Express routes, all operating out of one terminal freight house, and under the direction of one clearing house, each route being handled by one or two different operators, were put into service.

The shipments for all of these routes are solicited by a personal and telephone canvass through the clearing house, and it is the rare thing to find any of these trucks leaving the city with less than a capacity load.

Some of these routes are sustaining four trucks, five of them having an operator at each end, which plan will be adopted on each route.

Providing for an operator at the terminal end of each route solves the terminal distribution problem at these route terminals and adds materially to the resources for meeting emergencies.

The route or intermediate terminal operated by responsible cartage or commercial warehousemen, located at the terminal, has solved the problem of the return or intermediate loads.

The local cartage man, furniture or commercial warehouseman at intermediate points, find it profitable to represent a route operator at such points, as the local shippers use their service in sending shipments to terminal to be picked up by the transport truck.

The great advantage to the transport operator is the fact that he can make and keep schedules.

Another great advantage is an increased volume of business which the local man can secure for him, also the terminal higher established rates paid for the intermediate shorter hauls increases his tonnage income.

The established first-class rate for a 50-mile haul is about 50 cts. per 100 lbs., but if shipments are delivered and picked up at two intermediate points 15 miles apart, the rate is increased on the several shipments to $1 per 100 lbs. for the 50 miles.

The transport operator unloads a portion of his cargo to local terminals taking on additional consignments for other points along his route and pays 10 cts. per 100 lbs. for this terminal service, the terminal operator receiving a store-door delivery fee in addition.

The central clearing office and freight soliciting department is sustained by a fee of $1 per ton, which is paid by the operator.

Insurance covering every possible loss to shipper or consignee, excepting pilferage, is paid by the operator at the rate of 12 cts. per $100 value.

The following rates are collected to which is added a store delivery fee of 25 cts. for each stop and 5 cts. per 100 weight.

	1st Class	2nd Class	3rd Class
1 to 5 miles.....	.32	.27½	.21½
6 to 10 miles.....	.34½	.29½	.23
11 to 15 miles.....	.35½	.30	.24
16 to 20 miles.....	.38½	.33	.26
21 to 25 miles.....	.40½	.34½	.27½

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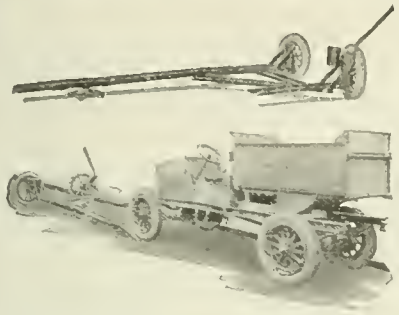
Designed and Constructed by a successful road builder. Saves time and Extra labor speeds up road work—costs less—does the work better.



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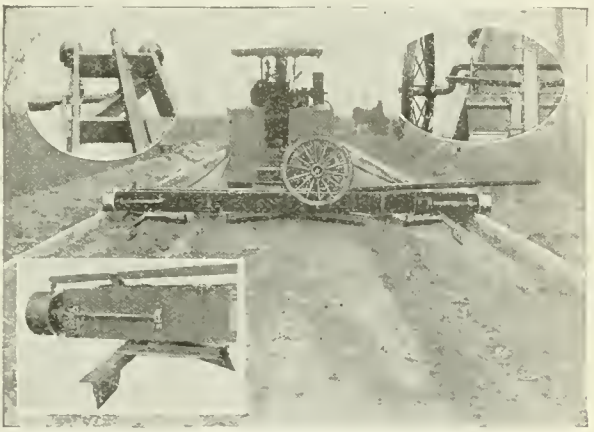
LABOR SAVER—CONCRETE SAVER—MONEY MAKER

Saves the labor of ten men per day. Pays for itself on first half mile. Trims the subgrade true to grade which meets any inspector's approval. Cutting depth is easily adjustable. Special crank axle and wheels provide easy transportation. Makes smooth flat or smooth crowned subgrade. Sturdily built. Used on industrial and truck haul jobs. Extra set of grader blades furnished with each machine.

Price for 18 ft. road size $450, f. o. b. Highland, Ill.

Coulter device, shown in insert in lower left side of cut, serves to keep machine in aligoment, protecting the forms from side pressure.



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Compares favorably in design, material and workmanship with best automobile or motor truck made.

Three forward speeds—cuts working time in half when load is light. Three point spring mounted suspension, fits it for work on rough or uneven surfaces.

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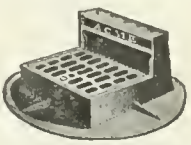

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927 Addison Road, CLEVELAND, OHIO.

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

This man took advantage of the offer on the opposite page. Read what he says about our Truck Advisory Service

"I beg to acknowledge receipt of your letters of May 2nd, May 4th and May 9th, enclosing data regarding the hauling of timber for general mining purposes which I requested of you in my letter of April 21, 1922.

"The information you have furnished me is proving very helpful to us and will greatly assist us in determining the cost of transportation and the proper make of truck to use in our work.

"I wish to thank you for the information you have furnished me and the assistance you have given in helping us to solve our problem."

We have done as much for others and will do as much for you.

Municipal and County Engineering

26 to 30 miles.....	.42	.35½	.28
31 to 35 miles.....	.45	.38	.30
36 to 40 miles.....	.46	.39	.31
41 to 45 miles.....	.48½	.41½	.32
46 to 50 miles.....	.51	.43½	.34½
51 to 55 miles.....	.52	.44	.35
56 to 60 miles.....	.52½	.45	.35
61 to 65 miles.....	.53	.45½	.35½
66 to 70 miles.....	.54½	.46	.36½
71 to 75 miles.....	.55½	.47	.37

The central freight station which is a section of a commercial warehouse is sustained by a fee of 2 cts. per 100 lbs. in and 2 cts. per 100 lbs. out or 80 cts. per ton for all freight cleared.

No freight is accepted below the third-class rate, and a special effort is being made by the soliciting department to secure as large volume as possible in first and one-half and double first-class shipments.

A carefully kept record on 10 3½-ton trucks operating over six different routes for a period of 30 days shows an average income of $38.60 per average day of nine hours.

From this income, each operator pays per truck soliciting or clearing house fee $1 per ton $3.50 freight house fee, 80 cts. per ton, $3.20 Insurance, $1.30 for average value of 3½-ton load, or a total of $8, leaving him $30.60 per day for a 3½-ton truck.

The plan has worked out so well that the Central Public Warehouse Company, which is now building a new commercial warehouse of 250,000 sq. ft. capacity, has included in its building plans the floor and platform facilities for all Inter-City Motor Express trucks now operating out of Indianapolis.

When separate motor transport terminals are established, large industrial centers with well populated surrounding territory will require an out-bound and an in-bound building or section.

These terminals could be established and sustained as private enterprises and be made profitable through a terminal hundred weight or package fee, to be added to the transportation charge, and through the operation of a cartage system which would be in great demand on pick-ups and deliveries to consignees and from shippers who do not operate their own cartage vehicles and from thousands of individual citizens who through highway transport and motor terminal service will become the direct consignees of agricultural producers.

These terminals should be established and sustained through the co-operation of wholesale shippers' associations, farm federations, and motor transport organizations.

The buildings should be long and narrow providing the greatest possible amount of platform space on each side of building, Insuring relief from either building, platform or vehicle congestion.

The building should be divided into route sections, local cartage vehicles delivering to platform on one side of building within route sections according to consignments, these consignments handled through narrow building to out-bound platform for shipment that day, or left within building if scheduled for following day shipment.

The in-bound building or section should be of the same character permitting in-bound transport truck to unload cargoes on one side of building, and local cartage vehicles to clear from opposite side.

Because of the flexibility of motor transport, terminals will be very well cleared daily.

For out-bound terminal, shipments consigned to routes over which less than daily service is rendered, should not be received earlier than one day prior to schedule departure of truck.

Schedules should be established over all routes offering tonnage in exchange for service, the terminal clearing house keeping all shippers informed as to schedules, transport rates and service offered.

As a large volume of the tonnage being transported by motor truck from industrial centers to rural communities is now being loaded at commercial warehouses, and as rapidly developing new sales and distribution methods will increase this volume, your committee on motor transport clearing houses suggest as an important early step in its activities, that this committee recommend to the American Warehousemen's Association, the provision for motor transport facilities in all new commercial warehouses.

Your committee also recommends that the constructive need of motor transport clearing houses as a means of stabilizing highway transportation, be brought to the attention of all interests devoted to, and affected by transportation problems.

POLICY OF NEVADA HIGHWAY DEPARTMENT WITH WORN-OUT MOTOR EQUIPMENT

The following statement of policy of the Nevada State Highway Department with respect to the disposal of worn-out motor equipment, was recently issued by the Departments.

One of the serious problems confronting an organization conducting operations over a wide territory and on a large scale, as is this Department, is the problem of transportation equipment for field work and the disposition of such equipment after it has been worn beyond economic repair. The Department has received, as surplus war material from the Federal Government, many trucks, tractors, autos, etc., some of which were new, but the majority of which were used machines. Oftentimes the used machinery is good for about one season's use; then to repair and keep it in running condition is more expensive than to replace with new equipment. The same condition holds true on equipment purchased new by the Department, the ordinary life of an auto being about three to five years, depending on the type of machine and the character of service on which it is used. Past experience has demonstrated the approximate economic life of machines of various types, and as much as two years ago a policy was adopted of trading in equipment which had reached the limit of economic repair on new equipment of a similar character. A policy of this sort, when founded on absolute incontrovertible cost records, proves a real measure of economy. During the past many exchanges of this sort have been made on Ford cars and trucks, and just recently a 1917 Cadillac car was traded in on a new car of the same make in this manner. We find that when the salvage value of a machine equals one-fourth of its original cost, and its repair to usable condition equals one-half its original cost, with continued operating costs about double that of a new machine, it is good business to turn the machine in on a new one. The lower operating costs within two years will offset the first cost in exchange; the machine still gives two to four years of further economical service, after which it has again reached the condition of the original machine and another replacement is made, and it thus continues as an unending circle.

TOLEDO ENACTS DRASTIC TRAFFIC ORDINANCE

The City Council of Toledo, Ohio, passed the following ordinance (No. 2437), regu-

MUSHROOM TRAFFIC LIGHT
AN ACCIDENT PROOF CAST STEEL
BRILLIANTLY LIGHTED
TRAFFIC MARKER
A unit that is indestructible, and even more conspicuous at night than in the day time.
It has low maintenance expense, no replacements, and is supplied with a Duplex lighting system, insuring constant service.
This unit is in use in over one hundred cities at the present time, giving perfect satisfaction.
The only cast steel unit on the market.
Bulletin on Request
Electrical & Specialty Supply Co.
MADISON TERMINAL BUILDING
Chicago, Illinois

lating traffic in the city of Toledo, on May 8, 1922:

Whereas, the traffic situation in the City of Toledo is dangerous to the public and should be remedied at once, and

Whereas, the subject matter herein provided for constitutes an emergency in that it is necessary for the immediate preservation of the public welfare; now, therefore,

Be it ordained by the Council of the City of Toledo (two-thirds of the members elected thereto concurring):

Section 1. That Section 1343 of the Toledo Code of 1919 be amended to read as follows: The driver of every vehicle shall stop such vehicle and remain at the rear of any street car which is stopping or has stopped at any regularly designated or usual stopping point to take on or let off possengers, so as to allow passengers free passage between the street car and the curb on the right, and the driver shall cause his vehicle to remain until such street car has resumed motion, except at such points at which safety zones are established and are marked by standards or stanchions connected by chains. In such case vehicles may pass street cars so stopping at a speed not in excess of 5 miles per hour, and shall clear the street car at least 6 ft.

Section 1343-A. Safety zones may be established by the Director of Public Safety along any street car line at any regularly designated street car stop; such safety zones shall be marked by standards or stanchions erected in the street and connected by chains, and no vehicle shall pass through said safety zone. Pedestrians shall enter and leave said safety zones from the end nearest street intersections or nearest a cross-walk.

Section 2. That Section 1359 of the Toledo Code of 1919 be amended to read as follows: No person shall operate and no owner thereof riding therein shall cause to be operated on any public highway in the City of Toledo, any motor vehicle or motorcycle at a speed greater than is reasonable and proper, having regard for width, traffic, use and general and usual rules of such road or highway, or so as to endanger the property, life or limb of any person; provided, that a speed greater than 15 miles per hour in the congested district as defined in Section 1290 of the Toledo Code, or greater than 20 miles per hour in other portions of the City of Toledo, shall be presumptive evidence of a rate of speed greater than is reasonable and proper.

Section 3. Any person upon being found guilty of violating any section or part of section of this ordinance, or of Section 1342 of the Toledo Code of 1919, shall be subject to the following penalties: Such person shall be prohibited from operating or driving a motor vehicle or motorcycle on the streets of the City of Toledo, for a period of not less than 30 days nor more than 60 days, and in addition thereto shall be fined not less than $5 nor more than $200, or imprisoned in the workhouse not more than 6 months, or both.

Section 4. Whoever operates any motor vehicle or motorcycle on the streets of the City of Toledo during a period for which said person has been prohibited from operating or driving a motor vehicle or motorcycle under the provisions of this ordinance shall, if convicted of such offense, be imprisoned in the workhouse not less than 10 days nor more than 60 days.

Section 5. If any part of the penalty provided by this ordinance shall be declared to be invalid, it shall in no manner affect the validity and enforcement of the remaining part of said penalty.

Section 6. That Sections 1343 and 1359 of the Toledo Code of 1919, be and are hereby repealed.

Section 7. That this ordinance, being an emergency measure, shall take effect and be in force from and after its passage.

REGULATIONS GOVERNING SPEED, WEIGHT AND DIMENSIONS OF MOTOR TRUCKS

(Editor's Note: Following is the text of the report of the Committee on Regulations Covering Speeds, Weights and Dimensions of Motor Trucks as presented at the recent annual meeting of the National Highway Traffic Association. Mr. Geo. H. Pride, 350 Madison Ave., New York City, is Chairman of the Committee.)

Your Committee has definitely and unanimously determined on the following:

Width, 96 ins., extreme dimensions.
Height, 12 ft. 6 ins., extreme dimensions.
Length, 30 ft., extreme dimensions.
Solid rubber tires, 800 lbs. per inch of tire width, measured at the base of the rubber.
Maximum axle loading, 22,000 lbs.

There still exists a diversity of opinion among the members of the Committee as to the maximum permissible weight per vehicle, the highway engineering mem-

bers refusing to approve the 28,000-lb. maximum, which was the consensus of opinion of the balance of the Committee. At the last annual convention of the Association in April, 1921, this question was referred to the members there assembled, and the convention by a large majority approved the 28,000-lb. limit, the highway engineering members still voting adversely.

The following speeds were adopted:

Weight.	Speeds—Country.	City.
4,000 lbs. gross weight..	25 miles	20 miles
8,000 lbs. gross weight..	20 miles	20 miles
12,000 lbs. gross weight..	20 miles	15 miles
16,000 lbs. gross weight..	15 miles	15 miles
20,000 lbs. gross weight..	15 miles	15 miles
24,000 lbs. gross weight..	15 miles	15 miles
28,000 lbs. gross weight..	15 miles	15 miles

We still consider that there is insufficient data available on the use of pneumatic truck tires to enable us to make any definite recommendations concerning them further than to say that the use of pneumatics seems to reduce the force of impact on the road surfaces to a certain degree, and also that experiments seem to indicate that they cause fully as much wear on hard-surfaced roads as do the solid tires, and even more wear on gravel and certain forms of macadam.

Your Committee wishes to say concerning trailers:

The only trailers that should be permitted to operate through congested regions should be so constructed that they would have no tendency to weave from side to side.

Laws concerning the number of trailers which would be permitted behind one tractor should be sufficiently elastic to limit the number to one, where traffic congestion is great, and to permit more than one where such congestion does not exist.

CONSTRUCTING HIGHWAY CURVES FOR TRAFFIC SAFETY

(Editor's Note: Following is the text of the committee report on "Status of the Construction of Highway Curves and Recommended Practice to Increase Safety to Traffic," presented at the recent annual meeting of the National Highway Traffic Association. Mr. H. Eltinge Breed, Consulting Engineer, 507 Fifth Avenue, New York City, is Chairman of the committee, and Messrs. W. G. Thompson and W. M. Acheson are the other members.)

The Association adopted as standard practice the resolutions numbered from first to tenth in the report, except that the third, eighth and ninth were *amended* as follows:

Third. That a line about 4 ins. in width, of appropriate color, be painted on the center line of pavement on all curves, both vertical and horizontal. This painted line to be renewed as necessary in order to keep it conspicuous and that it may indicate, to traffic in each direction, the limit of its half width of pavement.

Eighth. That in order to prevent the shoulders adjacent to hard-surfaced pavements from being "gouged out," gravel or crushed stone (1½ and 2½ ins. in size, mixed and filled with screenings) should be placed 2 ft. in width and 4 ins. in depth, on each side, maintained at the level of the pavement. An application of hot tar or asphalt on this gravel or stone will be found beneficial.

Ninth. That for public safety all advertising signs and obstructions along highway routes be eliminated except those erected by direction or permission of officials having jurisdiction over the highways and for public benefit.

Your Committee on Status of the Construction of Highway Curves and Recommended Practice to Increase Safety of Traffic made a Progress Report last year. This year it can offer definite recommendations for your decision, suggestions for your discussion and projects for your consideration.

The importance of safety on the highway, experienced more or less vaguely by all those interested in highway traffic, becomes tangible through definite figures. There are now registered in the United States 10,500,000 motor vehicles. This year's increase to that number is estimated by manufacturers at 1,800,000. The risk to safety lies in the congestion of 90 per cent of these vehicles upon 10 per cent of our roads. This risk we must minimize. That it is at present fraught with appalling loss of human life is evidenced by the casualties from automotive vehicle accidents—a loss yearly greater than is incurred by all other means of transportation combined.

The majority of these accidents of congestion occur under five conditions, all of which road-builders may help to eliminate.

Principal Causes of Highway Accidents

1. Sight distance on curves, both horizontal and vertical, which is insufficient to permit precaution against the other man's reckless driving. Lack of sight distance also increases the accidents at intersecting roads and at railroad crossings.

2. Insufficient width of pavement, especially in congested districts, which increases the number of cars that turn turtle on soft shoulders and hurtle down unprotected slopes.

3. The inadequate, irregular and improper spacing of danger signs, which encourages a general carelessness of their import. Judged by the number of accidents in their vicinity, they are a spur to the recklessness of the joy rider and a consequent risk to his sober brethren.

4. The tendency of detours under traffic to become almost impassable. On heavy-traveled routes traffic going in different directions should be routed over different detours; or if detours are inadvisable on account of dangerous or impassable conditions, the road should be built horizontally a half at a time.

5. Railroad grade crossings. To help prevent accidents to which these and other highway conditions are conducive, we may proceed at four points: First, to secure good design for new roads; second, to promote adequate improvement of old roads; third, to insist upon reconstruction of existing roads at places that have proven especially dangerous, such as grade crossings; fourth, to improve the location of the center line on dangerous curves and elevations. Under these headings the following recommendations are made. They aim to promote the safety of the traveling public as far as impersonal factors can do it, and they aim to diminish as far as possible the personal menace projected by the reckless driver; safety for the careful, with protection from the careless.

Need for Standard Practie

First of all, under the consideration of general safety for traffic, comes the necessity of standard practice throughout the country in respect to placement of danger signals, elevation and banking of curves, widening and regulation of traffic on curves. Standardization in these matters is imperative, because with the completion of transcontinental routes there is increasing interstate traffic. Drivers traveling to remote sections cannot be expected to apprehend distinctions in practice now existing between different highway departments, yet departure in our state from what they have become accustomed to expect in others, is a frequent cause of disaster. There is no real obstacle in the way of this standardization; it is merely a matter of agreement among State Highway officials and motor organizations.

Recommended Practice

Therefore, your committee proposes that you discuss, alter and finally recommend for standard practice the following resolutions in respect to general safety of highway traffic and to special precautions on curves:

First, that on all curves of more than 3 degrees the pavement and inner half of the earth shoulder be banked. This superelevation should vary from zero for a 3-deg. curve to 1 in. per ft. of width for curves of 20 degs. or sharper.

Second, that on all curves of more than 4 degs. the pavement he widened on the inside ½ ft. for each 1 deg. increase in curvature.

The widening and banking on a 4-deg. curve should start at a minimum of 50 ft. before reaching the point of curve and come to the fully widened and banked section at, or very soon after, reaching the P. C. Inversely, the regular section should be reached at a minimum of 50 ft. beyond the point of tangent for a 20-deg. curve; this varying or transitional width should be about 150 ft. long, with proportional lengths for intermediate curvatures.

Third, that a white line about 4 ins. in width he painted on the center line of pavement on all curves, this painted line to be renewed as necessary in order to keep it conspicuous and that it may indicate, to traffic in each direction, the limit of its half width of pavement. (See amendment in introductory note.—Editor.)

Fourth, that all sharp or dangerous curves, either simple or reverse, horizontal or vertical, should be posted about 500 ft. from each end with a sign indicating that danger exists and the direction of curvature. Railroad crossings at grade should be posted in a similar manner.

Fifth, that the National Highway Traffic Association recommend to all legislative committees preparing motor traffic laws that the attempt to pass a motor vehicle while going in the same direction, on a curve, either horizontal or vertical, where the unobstructed line of vision is less than 500 ft., be made a misdemeanor, and that all damages resulting from an accident under these circumstances be placed upon the passer.

Sixth, that the minimum radius of curves be 300 ft. unless prevented by an approach to a bridge not practicable to change or the improvement being on a village or city street, even to the end that new "right of way" should be procured

In order to increase the radius, bearing in mind that the improvement is being made for a long time, and that land values may increase to an extent prohibitive to procuring more right of way.

Seventh, that providing there is sufficient space within the "right of way," earth slopes be carried out with a 4 on 1 slope. If this is not possible, guide rail should be placed on the inner edge of all curves of more than 8 degs. This rail should be kept painted white and be about 4 ft. in height.

Eighth, that in order to prevent the shoulders adjacent to hard-surfaced pavements from being "gouged out," gravel or crushed stone (2-in. and 3-in. size, mixed and filled with screenings) should be placed 2 ft. in width and 4 ins. in depth, on each side. An application of hot tar or asphalt on this gravel or stone will be found beneficial. (See amendment in introductory note.—Editor.)

Ninth, that all advertising and other signs and obstructions along highway routes be eliminated except those exclusively proclaiming "Danger," and posted officially at 500 ft. from the point of danger, as provided in the fourth resolution. (See amendment in introductory note.—Editor.)

Tenth, that a definite sum be set aside annually by each highway department, and a comprehensive plan devised on which annual progress is made, for the elimination of the most dangerous grade crossings.

There are also suggestions and projects for the future that your committee would like to offer as a sort of progress report for your comment and opinion. They are debatable—are they sufficiently valuable to be accepted as working hypotheses to be proved by experimentation?

We believe that to minimize danger the proper highway officials in each community should make a survey of the bridges in that community and determine to what extent, if any, they should be strengthened in order to assure adequate support to increasing traffic. At present, some of us are in daily fear of disaster to heavy motor buses laden with humanity.

We believe that many congested routes should be widened as an economic and satisfactory method to safeguard traffic.

We question whether the increased security to the public and saving of time would not justify the cost of grade separations for traffic at intersecting crossings on heavily congested routes approaching large cities.

NEW HAVEN ENGINEERS HAVE SUCCESSFUL PUBLIC SPEAKING CLASS

To the Editor:

During the early fall of last year the New Haven Chapter of the American Association of Engineers secured the services of a teacher in public speaking and organized a class to meet on each Tuesday night.

Some members of the class were lukewarm and others saw in the work a chance to develop and improve a quality usually sadly lacking in engineers, namely, the ability to make an address clearly, concisely and with force, and to demonstrate their ideas, thoughts and convictions before a body of their peers.

The first few lessons brought out the fact that speaking before a body of men is not the easiest thing in the world. By speaking, I mean speaking and all that goes with it: such as confidence, poise, lack of self-consciousness, delivery, gesture, accenting, inflection, memory, etc., a weakness in any one of these sticking out like a sore thumb.

The class has kept steadily at its work, and at this date it does not seem like the same body of men who stammered and struggled through the first lessons. The members can now arise and make an address the way it should be made. They know what they should and should not do, and they do not feel as though the audience is pitying them and is wishing they would fade out of sight. They can get on their feet before a board of directors, a body of engineers, a public hearing, a civil court, or wherever necessary, and say: "I am in possession of certain facts that are of vital interest to you. They are assembled in my mind. I want to give them to you in a brief and intelligent way, and, what is more, *I can do it.*"

I will leave it to the readers of this article whether or not the average engineer can do this. He may think he can, but can he? I will also leave it to you as to whether such ability is an asset or a liability. Personally, I would not part with the benefit derived from my membership in the public speaking class for several hundred dollars, and that seems to be the sentiment of the other members.

Very truly yours,

William R. Marsden, of The Marsden Co., Engineering Bldg., New Haven, Conn., May 25, 1922.

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EDITORIALS

OPEN HOSTILITY TO HIGHWAY TRANSPORTATION

There are many electric interurban lines in Indiana that carry both passengers and freight. The development of highway transportation apparently has cut down the freight business of these lines, or at least promises to do so. Naturally, the interurban lines will not lose business if they can help it, and no fault can be found with their efforts towards self-preservation so long as they act fairly with the public, but when they frankly appeal to ignorance and blind prejudice in their efforts to discredit highway transportation, they are deserving of severe censure.

Many interurban cars operating on the Indiana lines bear large printed placards reading as follows: "Problem in Economics: Ship by Union Traction and save the highways. If a heavy truck earns 50 cts. per mile and damages the highway to the extent of $1 per mile, and the shipper of freight loses nothing, and the truck owner keeps the 50 cts., and the taxpayer pays the $1, where does the taxpayer get off?"

There are, of course, many fallacies in this hypothetical question propounded by the interurban lines. The damage of heavy trucks to highways is very much less than the value assumed in the question. For example, there are some gravel and stone roads leading into Indianapolis that carry at least 100 trucks a day for 300 days in the year. At the rate of damage assumed in the question these roads would be damaged annually at the rate of $30,000 per mile, but the fact is that these roads are maintained in good condition for less than $1,000 per mile per year. Quite a difference between biased assumptions and the facts in the case!

Other fallacies in the statement lie in the assumption that only the shipper and truck owner benefit by highway transportation; nothing is said of the ultimate consumer who, in the aggregate, makes up the general public. Also, the fact that the shipper, the truck owner and the ultimate consumer are themselves taxpayers is ignored.

However, it is not so much with the fallacies as with the plain intent of the question that we are concerned in this discussion. The plain intent is to discredit highway transportation, in the interest of interurban transportation, by making appeals to prejudice by means of false statements. If road construction can be checked, the development of highway transportation can be checked, and that is the object, or will become the object, of forms of transportation that compete with the highways for business, whenever the competition of the highways begins to "hurt."

We wish again to warn all workers in the highway field, and all who are interested in seeing a dependable and adequate system of highways constructed in the United States, that in safeguarding this great development it is not sufficient to rely on brotherly love alone. As we have before pointed out, the highways represent the purest form of public ownership, while the steam and electric lines represent the purest form of private ownership of public utilities. When these opposing interests clash the privately owned utilities will fight with every available weapon purchasable with gold. One such weapon is publicity calculated to misinform and mislead the public. Another such weapon is the controlled public official, whether he be in the city council, on the county board, in the state legislature, or in the Congress of the United States, who has opportunity to vote against appropriations for road construction or maintenance, on licensing and operating motor vehicles, etc. Our political history proves only too well that many men are willing to accept the financial backing of special interests during a campaign in exchange for later service to these special interests at the expense of the public. If the railways ever really believe, rightly or wrongly, that they will be injured by highway development, they will do all they can to kill the highway movement, and their all is very considerable.

The truth about highway transportation must be kept before the public or the public will quickly accept as true the false statements issued to injure highway de-

velopment. In Lincoln's famous statement about fooling the people the emphasis is usually placed on: "but you can't fool all the people all the time." It would be much better to place the emphasis on: "you can fool part of the people all the time," and to realize that this part lies somewhere between 99 and 100 percent, unless that which is true is advanced as consistently and as cleverly as that which is false.

Those who believe that highway development is for the good of the country as a whole will do well to be very active and alert in safeguarding this development. They will also do well not to fall too hard for railway propaganda of any kind.

"THE FREEDOM OF THE CITY"

To grant the "Freedom of the City" to an individual is to confer upon him the greatest honor within the gift of the city, next to the election to public office. This is a very old custom and whenever it is applied people are heard to make inquiry as to its origin and meaning. There are variants of the general idea. For example, while the city of New York has granted the Freedom of the City to an even one hundred men and women since the custom was instituted in the year 1702, to others it has granted merely the hospitalities of the city or the thanks of the city. One distinguished foreigner was officially invited to visit the city, but did not receive the freedom. Special tokens have been given to some, and formal receptions and parades have frequently been held in honor of a guest or resident of distinction.

The conferring of the Freedom of the City, now but a form of courtesy, dates back to the custom of making a man a citizen of a Roman city. In the Middle Ages a man was made a "burgher" or "burgess," and the American colonies followed the practice of making men burghers or freemen. To make a man a "freeman" gave him the right to vote, trade, hold office and enjoy all the rights of citizenship. The ceremony, as practiced today, is a tribute to an individual in the name of an entire city; it is purely honorary and has no legal aspects.

A very cosmopolitan group has received the Freedom of the City of New York in the last 60 years. The list includes military and naval heroes of our own and other countries, a journalist, a sculptor, a President of the United States, a king, two princes, a Cardinal, an Archbishop, two professors, and a Marshal of France. Some have been so honored who were prominent in the political life of a foreign country and who loomed large for the moment in the eyes of partially assimilated elements in the population of the city. In one case, that of "Doc" Cook, the Arctic explorer, the Board of Aldermen voted that their action in conferring the Freedom of the City had been "premature," and they demanded that he return the key to the city.

TOURIST CAMPS

Many cities have provided camping grounds for automobile tourists and others have expressed an interest in the subject. An article in this issue outlines the ideal arrangement of such a camp from the viewpoint of the sanitarian and the motorist. It is well to remember that there are other legitimate viewpoints, including that of the hotel man and the local taxpayer. Within reasonable limits these camps are worth while, but it is easily possible to go to unreasonable public expense in providing a place for the tourist to spend the night at a minimum expense to himself.

The average motorist is, perhaps, satisfied with the fatigue and discomforts of the day's travel, and when night comes prefers the accommodations obtainable at a hotel to those provided at even the best camp sites. It would seem wise, therefore, before spending much money on a new camp, to observe how many motorists make use of it. To begin with, perhaps it is sufficient to provide a site of ample size, on high ground, with good natural drainage. Guide signs to the camp should be placed on the roads leading to it. Then if the camp is used and there are indications that improvements in the way of water supply, sewerage, shelter, stoves, etc., will greatly extend its use, the local authorities can weigh the cost of these improvements against the benefits to the community in the form of direct business and general advertising. It is recognized that most communities, like most individuals, derive pleasure from showing courtesies and extending hospitality to the stranger, and this fact is likely to prove more potent than selfish considerations in prompting local authorities to provide camps for automobile tourists.

COMPARISON OF ROAD DRAINAGE BY DEEP SIDE DITCHES AND TILE DRAINS

By Charles M. Upham, State Highway Engineer, State House, Raleigh, N. C.

If we look over some of the earlier highway literature we find that one of the most emphasized details of construction was drainage of the highways. Nearly every one would talk drainage and plan for drainage systems, but when they commenced to construct a road, the drainage system was generally excluded on account of its cost, and this money was usually spent in the construction of the surface. That this was an unwise practice has been only too often proven. Scientific data now available give us more information relative to the regulation of moisture in the subgrade and the practice of stabilizing road foundations.

I think it is safe to say that, at the present time, road surfaces are standardized to a degree, at least, that we can practically be assured of satisfactory results if constructed in accordance with standard specifications. In many roads we have had sections of the road surface break up, while in other places it has proven strong enough to carry the traffic. Investigation has shown that the failure was not due to the road surface itself, but occurred on account of the failure of the subgrade or road foundation. This has led to thorough investigation of this subject, and before very long data will be collected and assembled so that the results of various researches will be made available for practice. It is practically accepted that the bearing power of any soil or subgrade will vary inversely with the amount of water that the soil or subgrade contains. With this fact to work upon it is readily seen that the more water present in any soil the less will be its bearing power or carrying capacity.

Subgrade Soils

The extent of the effect of moisture on any subgrade depends upon the kind of soil in the subgrade, so that it is readily seen that the selection of soils which go to make the subgrade is one of the most important factors in road construction. This detail is many times overlooked. In clay soils it has often been found that the soil nearer the surface of the ground is more satisfactory for subgrade construction. This undoubetedly is due to the fact that the soil has been broken up due to the action of frost, and that the finer material and colloidal matter has been washed out by the rains.

In the South there is what is known as top soil, which is a sand-clay composed of broken down rock, from which the finer colloidal matter has been washed. With the varying effects of moisture on the different materials it can be seen that the selection of soil for a subgrade is very important, and it is absolutely necessary to get a material of low capillary attraction and resulting high bearing value in the top of the subgrade. Many times the mistake has been made of taking all material from cuts and throwing it indiscriminately in the fills, whereas it would be to the great advantage of the road to select the material generally from the top of the cut and place this material on the top of the fill. In that way we would have the better material in the top of the subgrade and this would afford a higher bearing power for the construction of a road surface, which would have the same effect as increasing the depth of the slab.

Stabilizing Subgrades

There may be many methods of stabilizing subgrades. We cannot imagine any road so muddy and unserviceable that we could not build up a subgrade by putting a sufficient number of rocks or crushed stone in the subgrade. We could also go to the other extreme of imagining a subgrade constructed of solid concrete, and there are other impractical methods of stabilizing subgrades, but on account of large mileage of roads which must be built, and on account of the comparatively small amount of money available for road construction, it is absolutely necessary that the most economic means possible be used in stabilizing the subgrade.

It has been found and accepted by road builders that the most economic method of stabilizing the subgrade is simply to take away the water from the road foundation, or, better still, keep the water from getting into the subgrade. Therefore, one of the first principles in road construction is so to construct a drainage or sub-drainage system as to pipe away all springs or water from any source whatever, so that at no time would it be possible for any of this water to enter the subgrade and thus reduce its bearing power.

Keeping Water Away from Subgrade

This can generally be done by constructing ditches parallel with the roadway, the bottom of which are from 10 to 18 ins. below the subgrade or foundation of the roadway. When a road is hardsurfaced it prevents any water from above entering

the subgrade, at least until it has run to the edge of the pavement. The lateral side ditches intercept any water from horizontal capillarity or side seepage. There only remains then the water which rises up through the ground by capillary action. This is the most difficult and expensive water to take care of, and it can readily be seen that on account of the capillary action varying in different soils the selection of subgrade material is very important. It can safely be said that the amount of water drawn up into the subgrade depends upon the supply and the class of material in the subgrade. Generally speaking, the coarser the material the less the capillary action, and also the reverse is true to the extent that the finer the material generally the greater the capillary action, although within certain limits the capillary action in the coarser material is quicker than in the finer material, but the ultimate amount of water raised, and the height it is raised, is not so much in the coarse material as in the fine material. And inasmuch as it is the amount of water present in the subgrade which influences the stability of the subgrade, it can be seen that in selecting material for the road foundation the coarser material should be selected.

Capillary Water

From experiments performed by the Bureau of Public Roads it has been determined that the capillary water in a subgrade is greatest directly underneath the hard surface slab, which means that the part of the subgrade which should be the most stable is in reality greatly reduced in bearing power. However, the problem is to substitute for this portion of the subgrade a material which is less affected by the amount of water, or which has lower capillary action, which also means, that the water does not rise so high in this particular selected material, and this is another way of saying that the subgrade is more completely stabilized by this selected material, because the amount of water in the subgrade directly underneath the slab has been excluded by the selected material..

Various cross sections of roadways have been designed for the purpose of doing away with these various conditions, and, of course, one of the universal solutions of cross sections is the side ditch, which intercepts any water from the sides, which would otherwise get into the subgrade.

Side Ditch and Underdrain

This brings us up to the comparison of the side ditch and the tile underdrain, which generally consists of a ditch at the bottom of which is a pipe laid with loose joints and then the ditch filled in with crushed stone.

It has been thought best by many that since this was called a drain it effectively drained all the water from the subgrade, but, undoubtedly, in many soils this drain did little or no good other than to intercept any free water which might otherwise find its way to the subgrade. In other words, it is quite likely that this drain was only effective in taking away free water which came from the surface or seeped through the ground horizontally.

It is quite doubtful if any drain ever carried away any appreciable amount of water which rose by capillary action. Therefore it can be seen that neither the open ditch nor the tile underdrain is sufficient to cope with the capillary water in any subgrade. We must, therefore, design against capillary water in addition to the longitudinal drains.

Location of the Underdrains

In the subject of tile underdains there is a question as to their location. While the longitudinal underdrain will serve the purpose of intercepting water which would otherwise find its way to the subgrade, quite often transverse drains are necessary for the purpose of taking away water from springs or stratas which carry water underneath the road. The number and location of these drains absolutely depends upon conditions, and the amount of water which finds its way underneath the roadway. To carry the question of transverse drains a little further, and to develop the idea more completely, selected material which can be easily drained is some times placed underneath the road surface in thicknesses varying above 2 ins. This material should be connected up by drainable material to the nearest drain or ditch. This is another very effective means of reducing the amount of water underneath the road slab which is a means of increasing the bearing value of the subgrade or road foundation.

The location of a lateral or longitudinal drain has been the subject of considerable discussion. One suggestion is to place the drain directly underneath the ditch, but this seems to be the improper place on account of water flowing in the ditch carrying the finer silt particles into the drain, which gradually make it less effective. It is undoubtedly bettetr to construct the drain higher up on the shoulder and a little nearer the roadway surface.

Chemical Treatment of Subgrades

There are many methods now being devised for the treatment of subgrades in order to overcome the water of capillarity, and to insure more complete stabilization, various chemicals are being used to experiment in the treatment of subgrades. Water-gas tar is a substance which has been used in subgrade experimentation. Other experiments show that Portland cement has an advantage in stabilizing subgrades. Experiments with low capillary material suggests that cinders, sand, gravel, or crushed stone will bring about a stabilized subgrade only in a different manner. In all cases, the treated or selected subgrade material should be connected with the tile drains or ditches or drainage system, by means of the most drainable material, and the subgrade, even if built of selected material, must be so constructed as to drain as completely as possible.

Comparison of Open Ditch and Tile Drain

We are now to the question of the comparison of the open ditch and tile drain. Neither of these is a cure-all. In some instances they help materially, but in other cases their effect is slight. There is a particular experiment which has been watched for several years. It is a surface treated macadam road. This particular road broke up every spring as the frosts came out of the ground. A complete investigation was made and what remained of the macadam surface was cleared away and, although it was expected to find a spring underneath the roadway, the only thing which was found was a layer of clay slightly over an inch in thickness. This layer of clay was slightly tilted to such an extent that water would percolate through the ground until it reached it, and then on account of this impervious clay layer, water would follow along on top of it and appear underneath the road surface. This amount of water on top of the strata of clay so weakened the road surface and subgrade that it broke up each year. It was noticed that this strata of clay was underlaid with a very coarse and easily drained sand, and the water which had collected on the clay strata was easily drained down through the holes cut in the clay strata. This matter is being mentioned to show that the flow of water in certain soils is very slight and that tile drains will have very little beneficial effect in such soils.

In many instances it has been found that the flow of water in different soils varies from 1 ft. a day up to 20 or 30 ft. a day in clay soils. There is some question relative to the depth of drains and ditches. It is very evident that a ditch will intercept water the same as a tile underdrain, and also the tile underdrain will have the same effect in intercepting water as an open ditch. It is assuming that both are maintained. It is quite evident that it is more difficult to maintain a ditch than an underdrain on account of the fact that in tile drains the pipe is always available for the free water, whereas if an open ditch becomes stopped up the free water is backed up and allows a bigger supply of water for capillary action in the subgrade. The deeper the ditch the more difficult it is to maintain, and one more important point is the fact that a deep ditch must be maintained by hand, which should eliminate this kind of ditch from consideration only where the depth of the ditch is necessary for water drainage. In many instances a shallow ditch can be maintained by a road machine.

Effect of Frost on Tile Drains

The value of a tile drain is sometimes completely lost under certain conditions of frost, and in many instances the effectiveness of a tile drain is practically of no value, although there may possibly be a very slight movement of water through frozen ground. This, however, is very slight. In this particular instance, no doubt, the open ditch would be more effective, especially in taking care of any surface water, which through certain weather conditions such as a thaw, might be present.

Probably the most critical time for any road is after the ground has been frozen for some 2 or 3 ft. Under these conditions the effect of the tile drain would be greatly reduced. If this freeze is followed by a thaw the surface of the road is first affected and this condition brings about an excess of water on the surface of the road and directly underneath the slab. On account of the frozen material underneath, the free water cannot pass down into the drain and thus, in this instance, the value of a tile underdrain is reduced to a minimum. A more effective solution in this case is a shallow gutter. By this is meant a gutter from 10 to 18 ins. below the subgrade with the shoulders and slopes so constructed that surface water and any free water occasioned by a thaw can readily find its way to the gutters.

It is assumed that all underdrains and ditches are constructed to grade and will thus quickly carry away any free water. Another very important point is that any free water which might for any reason exist in the subgrade must have a method

whereby it can pass off immediately to the drain or ditch. In the case of ditches the existing conditions must be thoroughly studied before the location and depth is determined. If you are constructing a road on a fill, of course, there is no water to intercept, but in a cut which is on light grades or on side hill work, an intercepting ditch is very effective. On the heavier grades it is not necessary to make the ditch as deep as on the lighter grades, for the grade of the roadway has the same effect as the deeper ditch. If the ditches drain readily, all indications seem to point to the conclusion that it is seldom necessary to construct any ditch deeper than 2½ ft. or 3 ft. below the grade of the road. It is sometimes necessary to do so to get a suitable grade to drain the system.

In summarizing, no distinct advantage can be claimed for the tile drain above the open ditch; nor can it be said that the open ditch is more favorable at all times than the tile drain. But there are certain conditions where a combination of the two will be the most practical. If an open ditch is used there is no advantage in making it any deeper than to intercept water, and should not be so deep that it cannot be maintained by machine; otherwise the maintenance will be a costly item. An open ditch can be used to intercept water as effectively as a tile drain. The open ditch must be constantly maintained and represents a hazard to traffic. On the other hand, a tile drain will serve as well as an open ditch when used to intercept water from getting under the roadway. The maintenance of a tile drain is generally less than the open ditch, although many times its original cost of construction is greater. At no time does the tile drain present any hazard to traffic, and for this reason it should be given serious consideration.

Undoubtedly no decision can be made to the extent of stating that either the open ditch or the tile drain is preferable, but it can safely be said that there are conditions when it is more economic and desirable to use either one or the other. After a careful consideration of all the details it is quite likely that a combination of the open ditch and the tile underdrain is more suitable than either the one or the other.

In no case is it necessary to construct the open ditches or tile drains lower than that point which will intercept water, for, in practically no instance do the drains reduce the amount of capillarity, and after all a combination which will most economically reduce the amount of moisture in the subgrade is the method to be selected, taking into consideration the first cost, cost of maintenance, and giving due consideration to any hazards which might be interposed on account of the open ditch.

The foregoing paper by Mr. Upham was presented before the Eighth Annual Conference on Highway Engineering at the University of Michigan.

THE DISPOSAL OF SEWAGE SCREENINGS

By William F. Morse, Consulting Sanitary Engineer, 1007½ Kee Mar Park, Cleveland, Ohio.

One of the many problems dealt with by superintendents of sewerage plants is the disposal of the screenings that are the invariable accompaniment of all sewerage work.

The daily flow of sewage carries a body of organic and inorganic matters and substances that must be detained and removed before the process of purification can begin.

After passing the grit chamber that detains the more solid parts the sewage passes through a series of screens, vertical, horizontal or inclined, and spaced with openings according to the general character of the sewage. These floating substances are caught and held until the screens become clogged and require cleaning. The daily amount of the screenings varies with each locality and with the seasonal discharge of sewage. When the surface waters, or unauthorized connections are allowed to enter a sanitary sewer system beyond the customary moderate allowance of capacity, there is a corresponding increase in quantity, and there may be a radical change in the character of the screenings. The effect of this is forcefully pointed out in the article on "The Abuse of Sanitary Sewer Systems," in the April issue of Municipal and County Engineering.

There is but little accurate information available in regard to the daily amount of screenings, since this depends so largely upon conditions, as pointed out, but under usual conditions, with the type of inclined screen commonly in use, sewers discharging at the rate of 1,000,000 gal. per day will carry from three to five bushels of screenings. Estimating one heaped bushel at 1¼ cu. ft., and the screenings (as collected) at 75 to 80 lbs. per cu. ft., the daily amount per 1,000,000 gals. would

be 400 lbs. carrying approximately 320 lbs. of water in suspension.

In one city of 900,000 population the daily amount of screenings from two-thirds of the population is estimated at a maximum of 15 cu. ft. per hour, containing 80 per cent liquids and 20 per cent solids. After the screenings are passed through presses at 150 lbs. pressure per sq. in., the expected weight is 60 lbs. per cu. ft., 900 lbs. per hour, and the moisture content is 70 per cent. These estimates are based upon the operation of a smaller sewerage plant in another section of the city.

In a neighboring city of a population of 70,000, with an average daily flow of 1,000,000 gals., the screenings are about 3½ bushels per day. It would appear that the screenings in the normal sewage flow from northern and western cities, where there is no single element or item of unusual prominence in the sewage, there would be approximately from three to four bushels, equivalent to 3.75 to 5 cu. ft. for each 1,000,000 gals.

But when the sewage is treated by a method different from that of the usual type of sewerage plants there may be a wide variation in the liquid and solid constituents of the sewage.

In 1914, the city of Long Branch, Cal., population 30,000, contracted for the installation of the Riensch-Wurl Screen, a German device for the separation of sewage into its liquid, solid and semi-solid constituents. From the combined systems of surface waters and sanitary sewers, the maximum flow of sewage was estimated at 2,000,000 gals., or about 150 cu. ft. per day. The liquid content was expected to be 80 and the solids 20 per cent.

The solids extracted by this method were to be destroyed by incineration, using for the purpose oil fuel at 8 lbs. per gal., at the cost of 70 cents per bbl.

Upon completion of the plant it was found that the daily flow was 105 cu. ft., and that the liquid content was somewhat in excess of the estimated 80 per cent, while the weight was slightly above 75 lbs. per cubic ft.

To destroy the solids an incinerator was designed by the writer and built by the contracting company, under a guarantee that 5 lbs. of oil should incinerate 1 cu. ft. of sludge, in a completely sanitary manner, without nuisance, and with the labor of one man.

This incinerator was a special construction, built under the patents of the writer, and comprised three separate chambers of large area providing for the rapid evaporation of moisture, the utilization of all heat units in the fuel, and apparatus for the complete and final destruction of all noxious gaseous products. The temperatures in the upper chamber averaged 2,200 deg. F.; in the second, 1,600 deg. F.; in the lower, 1,200 deg. F., and 600 to 800 at the chimney flue. The chimney was of radial brick construction, 75 ft. high, and lined to the top with fire-brick.

In later years, when the price of oil had increased, natural gas at a low cost was substituted for oil, with a corresponding decrease in operating expense. At this plant it has, moreover, been found that the percentage of liquids in the sludge has become 85-87 per cent, and that the sludge has practically no calorific value.

Screenings contain a mass of decaying organic contaminated matter in its last and most objectionable and threatening form. If taken away for earth burial there is always to be considered the factor of expense for hauling and sanitary supervision. A much better way is to destroy the residuum of a sewage disposal plant by incineration in properly designed, thoroughly tested furnaces.

When the sewerage works have a power plant with a chimney of reasonable height the problem is solved at once by the installation of an incinerator that may be connected with the chimney or with the boiler smoke-pipe. This incinerator occupies a small area of space, in or adjoining the boiler room, as near as possible to the screens, however, in order that the collections may be economically handled, with the least exposure of the employees to contagion. The location, dimensions, capacity and general arrangements should be designed to suit the local conditions.

In large sewerage plants a vertical steam boiler of suitable capacity will furnish power for operating sewage presses, steam-heating for the laboratory or other buildings, or will supply hot water for cleansing and other uses. The boiler may be fired independently of the incinerator when needed, but will depend for usual operation upon the heat from the screenings and the necessary fuel to maintain combustion.

This method of disposal, by self-contained continuously working incinerator, is the most economical, practical, sanitary way of solving the problem of the disposal of sewage screenings of any character, and in any quantity.

THE THRUST IN SKEW ARCHES

By Daniel Royse, 2143-17 Battery Place, New York, N. Y.

Rankine, in "Manual of Civil Engineering," article 295, says:

"Skew arches are of figures derived from those of symmetrical arches by distortion in a horizontal plane. The elevation of the face of a skew arch, and every section parallel to its face, being similar to the corresponding elevation and vertical section of a symmetrical arch, the forces which act in a vertical layer or rib of a skew with its abutments, are the same with those which act in an equally thick vertical layer of a symmetrical arch with its abutments, of the same dimensions and figure, and similarly and equally loaded.

"The angle of skew, or obliquity, is the angle which the axis of the archway makes with a perpendicular to the face of the arch. The span of the archway 'on the square,' as it is called (that is, the perpendicular distance between the abutments) is less than the span or skew, or parallel to the face of the arch, in the ratio of the cosine of the obliquity to unity. It is the span on the skew which is equal to that of the corresponding symmetrical arch."

Hool, in "Reinforced Concrete Construction," volume III, page 43, section 22, says:

"Skew arches may be treated exactly as right arches, the span being taken parallel to the center of the line of the roadway and not at right angles to the springing lines of the arch."

The foregoing quotations comprise the theory and practice of the design and construction of skew arches as presented in the text-books.

Luten, in a pamphlet on "Skew Arches," published in 1921, states a theory, confirmed by observation of expansion joints in the spandrel walls of skew arches built of reinforced concrete, which is contrary to that generally accepted. He says:

"The theory on which the design of such arches is based is substantially the same as for a right arch, except that a heavier thrust is exerted against that end of the abutment at the obtuse angle and should be resisted by a greater mass in that end of the abutment. The placing of the reinforcement is of the first importance, the transverse reinforcement, particularly not following the rule for a right arch."

The writer has sought to develop a method for analyzing the stresses in a skew arch so as to determine how much the resultant thrust is diverted toward the obtuse corners of the arch, with consequent eccentric loading of the abutments.

Consider a skew arch (Fig. 1) with the skewbacks at AB and CD, and with the axis of the arch rib as shown in elevation at A'E'C'. Rib shortening will cause the crown to drop and the rib axis to take the position A'G'C'.

If the arch were cut through the crown and the changes in length and in position

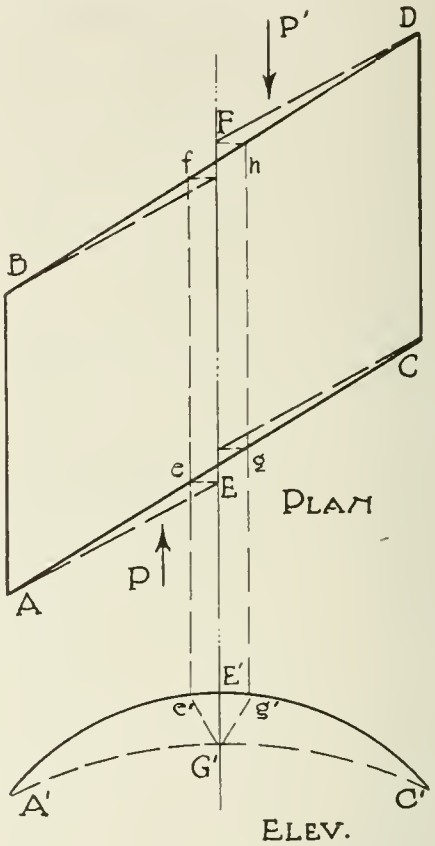


FIG. 1.

taken separately, there would be: First, a shortening of each half of the arch in the direction of the roadway so that the center edges originally both on line EF, are at ef and gh, respectively. Second, bending or rotation about the skewbacks until the center edges are again in contact.

At the crown the two halves do not touch for the entire width, and the plan of the shortened arch rib is as indicated by the broken lines. To bring the faces of the arch into unbroken surfaces again

will require forces applied as indicated by the arrows P and P', which will increase the abutment reactions at the obtuse corners B and C, as compared with the stresses at the acute corners A and D. If a solid arch be strained as described the equivalent of the assumed forces P and P' will be set up as internal stresses.

As to how the assumed thrusts, all parallel to the center line of the roadway are diverted to produce an eccentric application of their resultant at the abutment:

Consider the skew arch of obliquity B as made up of separate thin layers parallel to the face, each layer being a narrow right arch, and take two adjacent layers,

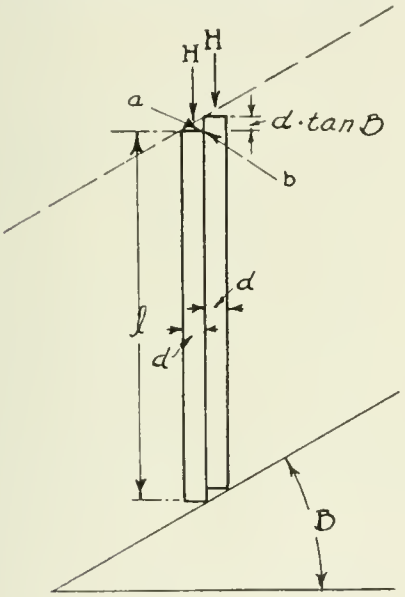


FIG. 2.

each of length l and width d (Fig. 2). Under a stress of H per unit area of cross-section point a will move toward the abutment a distance of (H÷E)l, E being the modulus of elasticity, while point b originally adjacent to a but on the second lamina, will move a distance of only (H÷E) (l—d tan B). Thus point a moves a distance (H÷E) d tan B relative to point b. If point a be fastened to point b as would be the case in a monolithic structure, there would result a transfer of stress from the longer to the shorter lamina. Such transfer of stress from lamina to lamina means greater stress at obtuse corners.

If a concentrated load be supported on a number of separate columns (Fig. 3) of equal cross-section and varying length, the distribution of the load among the column is inversely as their respective lengths, since stress is proportional to unit strain and (the total strain being the same for all columns) the unit strain is inversely as the column length.

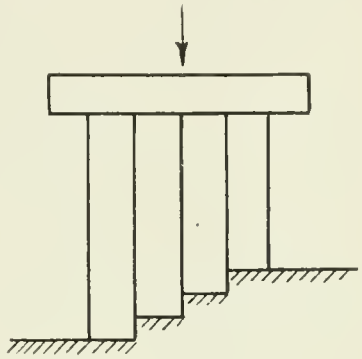


FIG. 3.

If a number of equal loads be imposed on a monolithic support (Fig. 4), the various sections if free from each other would be strained directly as the length of each, but as the sections are connected there is a tendency to equalize the total strains, with increased unit strain at the short end and decreased unit strain at the long end, and if the top of the support as loaded is parallell to its original position the stress developed in each section will be inversely as its length.

If in a skew arch there be a diversion of the resultant thrust to an eccentric

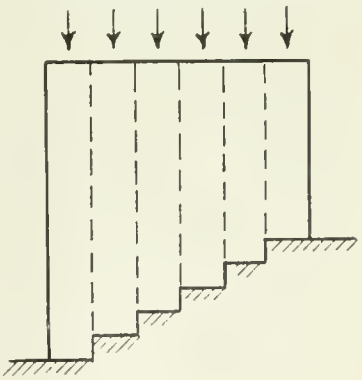


FIG. 4.

position such as T-T' in Fig. 5, the diversion must be caused by an equalization of the total strains of unequal longitudinal elements under equal thrusts, and there will be some line through the middle point of the crown, as J-J' in Fig. 5, which has not changed its direction as a result of the straining of the arch,

and applied at which uniformly distributed thrusts will produce equal total strains in the longitudinal elements extending from J-J′ to the abutment. Equal total strains mean unit strains, and hence stresses, inversely as the lengths of the elements.

It should be remarked that the actual thrusts of the arch which are taken as being applied at section J-J′, are equal stresses per unit area of cross-section, since in a properly designed arch the thickness of the arch rib is increased from crown to abutment in the same proportion as the tangential thrust increases relative to the horizontal thrust.

The lengths of the longitudinal elements are to be measured along the curve of the arch, that is measured on the development of the neutral axis and not on the plan of the arch. Lines on the arch which lie in vertical planes parallel to the center line of the roadway and appear in plan as right lines, will be circumflex curves on the development. Strictly, in this analysis the length of longitudinal elements should be measured along the curve of the development but no sensible error results if measurements be made along the chords. Line J-J′ which appears as a right line on the development is a circumflex curve on a plan view.

Fig. 6 is the development of the neutral axis of an arch rib of length=s, length

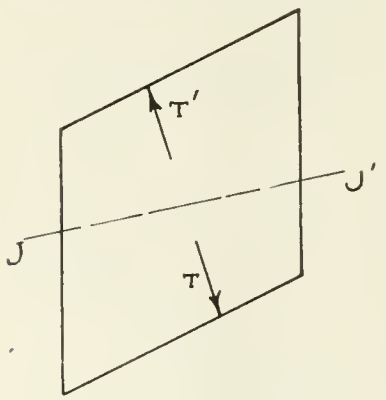


FIG. 5.

of abutment=a, and obliquity (on the development)=C. J-J′ is the datum line at which the actual thrusts are applied, and from which the longitudinal elements are measured; J-J′ makes some angle=E with a perpendicular to the line joining the abutment ends.

From the definition of J-J′, the unit stress, p, transmitted to abutment along any longitudinal element of length l, is $p=(p'\,l')\div l$.

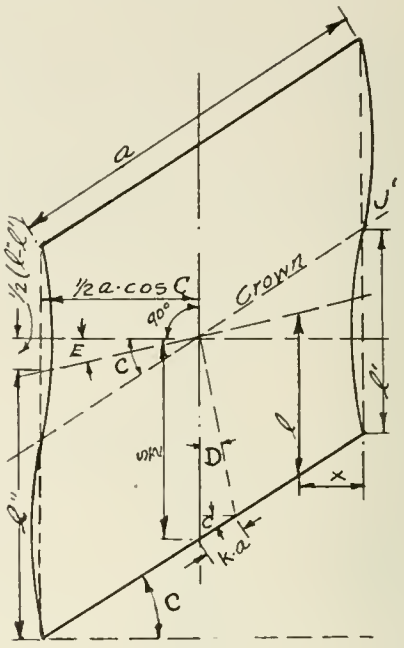


FIG. 6.

From Fig. 6, $l=l'+\dfrac{x}{a\cos C}(l''-l')$ and

$$p=p'\,l'\div\left[l'+\frac{x}{a\cos C}(l''-l')\right]$$

Denote the ratio of l″ to l′ by m. Then

$$p=\frac{p'\,a\cos C}{a\cos C+x\,(m-1)}$$

The thrust transmitted by an element of width dx is

$$dF=p\,dx=\frac{p'\,a\cos C}{(m-1)}\cdot\frac{(m-1)\,dx}{a\cos C+x\,(m-1)}$$

The total thrust is the integral of dF between the limits x=a cos C and x=0 and is

$$F=\frac{p'\,a\cos C}{m-1}\cdot\log_e m$$

Taking moments about the obtuse corner, the moment of dF is dM=xdF=pxdx.

$$=\frac{p'\,a\cos C}{(m-1)}\left[\frac{(m-1)\,x\,dx}{a\cos C+x\,(m-1)}\right]$$

$$= \frac{p' a \cos C}{(m-1)} \left[dx - \frac{a \cos C \, dx}{a \cos C + x (m-1)} \right]$$

The total moment is the integral of dM between the limits x=a cos C and x=o, and is

$$M = \frac{p' a \cos C}{(m-1)} \left[a \cos C - \frac{a \cos C}{(m-1)} \log_e m \right]$$

The abscissa of the point of application of the resultant at the abutment will be

$$\frac{M}{F} = \frac{a \cos C}{\log_e m} - \frac{a \cos C}{m-1}$$

or, measured along the abutment the resultant is at a distance of

$$\left[\frac{1}{\log_e m} - \frac{1}{m-1} \right] a$$

from the obtuse corner, and at a distance of

$$\frac{a}{2} - \left(\frac{1}{\log_e m} - \frac{1}{m-1} \right) a$$

$$= \left[\frac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m} \right] a$$

from the middle point of the abutment.

The ratio of this distance to the abutment length is defined as the "eccentricity of the resultant thrust" and denoted by

$$k = \frac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m}$$

From Fig. 6,

$$\tan D = \frac{k \, a \cos C}{\frac{s}{2} - k \, a \sin C} = \frac{k}{\frac{s}{2 \, a \cos C} - k \tan C}$$

Also from Fig. 6,

$$\tan C - \tan E = \frac{\frac{1}{2}(l''-l')}{\frac{1}{2} a \cos C}$$

$$\frac{l''-l'}{a \cos C} = \frac{s}{a \cos C} \left(\frac{m-1}{m+1} \right)$$

since

$l''+l' = (m+1)l' = s$, and $l''-l' = (m-1)l'$.

$$\text{Hence } \tan E = \tan C - \frac{s}{a \cos C} \left(\frac{m-1}{m+1} \right)$$

The value of the angle E which the datum line J-J′ makes with a perpendicular to the line joining the abutment ends, depends upon the figure of the structure and the physical properties of the material of which it is built. The physical constants involved not being known, it is proposed to assume a relation between the angle E and the angle D, both of which are functions of m. In order to determine m and compute the eccentricity, k.

Any assumption made should be such as will give rational results at the limits between which the figure of the structure may vary. With the length of the development constant, the figure will vary as the obliquity varies, or as the width varies.

Consider the obliquity as the variable: One limit is zero (the arch is a right arch) and then angle D and angle E are equal, each being zero. The other limit for the obliquity is 90 degrees, and as this limit is approached the length of the barrel of the arch becomes very great relative to the span, a figure in which the resultant thrust is normal to the abutment (though the eccentricity is small because of the extreme length of the abutment), and the datum line approximates the line of the crown of the arch; at the limit angle D and angle E are equal, each being equal to the obliquity, 90 degrees.

Consider the ratio of width to length as the variable: When the width is very great the abutment is very long relative to the span and the resultant thrust is normal to the abutment, with angle D and angle E each equal to the obliquity. As the width approaches zero, the thrust must be along the narrow arch rib, with angle D and angle E each equal to zero.

It is believed to be reasonable, therefore, to assume that the angle D and the angle E are equal for the intermediate conditions, and that the two equations involving m may be combined as

$$\frac{k}{s} = \tan C - \frac{s}{a. \cos C} \left(\frac{m-1}{m+1} \right)$$

$$\frac{}{2 \, a. \cos C} - k \tan C$$

where $k = \frac{1}{2} \left(\frac{m+1}{m-1} \right) - \frac{1}{\log_e m}$.

Then for given values of a, s and C,

TABLE I—VALUE OF K=ECCENTRICITY OF RESULTANT THRUST.

a cos C / sin C: (Angle of Skew of Development=C)												
s	.40	.45	.50	.55	.60	.65	.70	.75	.80	.85	.90	.95
.1	.007	.009	.010	.011	.013	.015	.016	.019	.022	.027	.035	.052
.2	.014	.017	.020	.022	.026	.029	.032	.038	.044	.055	.072	.110
.3	.021	.025	.029	.033	.038	.043	.049	.057	.067	.084	.113	.200
.4	.028	.032	.038	.044	.050	.056	.064	.075	.088	.110	.155	.270
.5	.035	.040	.045	.052	.060	.068	.078	.090	.110	.143	.200	.270
.6	.041	.046	.051	.059	.069	.080	.095	.110	.132	.167	.217	.224
.7	.047	.052	.058	.067	.079	.092	.105	.124	.150	.190	.215	.200
.8	.050	.056	.064	.072	.085	.097	.114	.133	.160	.184	.203	.175
.9	.053	.060	.069	.077	.090	.102	.123	.140	.162	.183	.190	.160
1.0	.057	.064	.072	.081	.094	.107	.125	.143	.160	.174	.177	.144
2.0	.060	.067	.074	.082	.090	.098	.106	.114	.120	.113	.094	.072
3.0	.049	.055	.060	.064	.068	.072	.076	.080	.079	.073	.064	.046
4.0	.040	.045	.049	.053	.056	.058	.060	.060	.059	.056	.049	.035
5.0	.033	.037	.039	.041	.044	.046	.048	.048	.047	.044	.040	.029
10.0	.017	.019	.021	.022	.023	.024	.024	.024	.023	.022	.019	.014

various values may be assigned to m and the equation in k solved by trial. By this method k was computed for different values of (a cos C) ÷s and of tan C. The values of k thus found were then modified so as to make sin C instead of tan C one of the arguments and are exhiibted in Table I.

For arches having a width of roadway not exceeding 60 per cent of the span and an obliquity not exceeding 60 degrees the eccentricity as shown in Table I is well expressed by the approximate formula

$$k=1/6.\ \frac{a.\cos C}{s}.\ \tan C=\frac{a.\sin C}{6s}.$$

Since the sine of the obliquity of the arch, B, is offset of abutments divided by the span (which is denoted by u), and the sine of the obliquity of the development, C is offset of abutments divided by the length of a longitudinal element (taken as equal to the length of the neutral axis and denoted by s), the angles B and C are connected by the equation u sin B=s sin C.

The width of the arch perpendicular to the roadway may be denoted by w= a cos B.

Hence the approximate formula for eccentricity may be put

$$k=\frac{a.\,u.\sin B}{6\,s^2}\ \text{or as}\ k=\frac{w.\,u.\tan B}{6\,s^2},$$

where a=length of abutment,
w=width of arch,
u=span on the skew,
s=length of arch rib along the neutral axis,
and B=obliqnity of the arch (not the development).

Table II exhibits the relation between k and m.

For example, take an arch of obliquity B=15 degrees; span u=100 ft.; length of arch axis s=106 ft. (corresponding to a rise of about 15 per cent of span); width w=40 ft. Then sin B=.25882; cos B= .96593; sin C=u/s sin B=100/106×.25882 =.24417; C=14 deg. 8 min.; cos C= .96974; a=40/cos B=40/.96593=41.411 ft.; (a cos C)/s=(41.411×.96974)/106=.379.

Interpolating in Table I between 0.3 and 0.4 for (a cos C)/s and between 0 and 0.4 for sin C, gives k=0.016 for (a cos C)/s=0.379 and sin C=0.244.

TABLE II.

m	k	f(m)	m	k	f(m)
1.1	.0080	.0476	1	.0000	.0000
1.2	.0152	.0909	2	.0573	.3333
1.3	.0217	.1304	3	.0898	.5000
1.4	.0280	.1667	4	.1120	.6000
1.5	.0337	.2000	5	.1287	.6667
1.6	.0391	.2308	6	.1419	.7143
1.7	.0440	.2593	7	.1529	.7500
1.8	.0487	.2857	8	.1620	.7778
1.9	.0531	.3103	9	.1699	.8000
2.0	.0573	.3333	10	.1768	.8182
2.1	.0613	.3548	11	.1830	.8333
2.2	.0650	.3750	12	.1885	.8462
2.3	.0686	.3939	13	.1934	.8571
2.4	.0720	.4118	14	.1980	.8667
2.5	.0754	.4286	15	.2021	.8750
2.6	.0784	.4444	16	.2060	.8824
2.7	.0814	.4595	17	.2095	.8889
2.8	.0844	.4731	18	.2128	.8947
2.9	.0871	.4871	19	.2159	.9000
3.0	.0898	.5000	20	.2188	.9048
3.1	.0923	.5122	21	.2215	.9091
3.2	.0948	.5233			
3.3	.0972	.5349	30	.2405	.9355
3.4	.0996	.5454	40	.2546	.9512
3.5	.1018	.5555	50	.2648	.9608
3.6	.1039	.5652	60	.2727	.9672
3.7	.1060	.5745	70	.2791	.9718
3.8	.1080	.5833	80	.2845	.9753
3.9	.1100	.5918	90	.2890	.9780
4.0	.1120	.6000	100	.2930	.9802

m=Ratio of unit stress at obtuse corner to unit stress at acute corner; or ratio of length of arch from datum line to abutment at acute edge to length of arch from datum line to abutment at obtuse edge.
k=Eccentricity of resultant thrust.
f(m)=(m—1)/(m+1).

For this arch the approximate formula gives $k=(w.\ u.\ \tan B)\ (6\ s^2)=(40\times100\times .26795)/(6\times106\times106)=.0159$.

From Table 11, if k=.016, m=1.21 and the unit stress at the obtuse corner is 1.21 times the unit stress at the acute corner.

Measurement of the stress developed by models of skew arches made of 1 16-in. flexible packing and suspended as catenary hammocks confirmed, qualitatively, the theory of the foregoing analysis. In working with the models it was found to be extremely important that the skewbacks be parallel and in the relative longitudinal positions for which the arch was designed. Slight displacement of one skewback longitudinally toward the obtuse corner causes a relatively large increase in the eccentricity of the resultant thrust, and displacement toward the acute corner causes a corresponding decrease in eccentricity. If the obtuse corner is dropped below its proper level the eccentricity of the resultant thrust is decreased, and if the obtuse corner be raised above its proper level the eccentricity is increased.

RECOMMENDED PROCEDURE IN THE CONSTRUCTION OF GRANITE BLOCK PAVEMENTS

By Clarence D. Pollock, Mem. Am. Soc. C. E., Consulting Engineer, Park Row Bldg., New York, N. Y.

Great improvements have been made in granite block pavements during the last dozen years, both in better made blocks and the laying of the pavements.

Standard Size Block

The adoption of the standard paving block, 3½ to 4½ in. in width, 4¾ to 5¼ in. in depth and 8 to 12 in. in length, so generally was a great step in advance. The block makers have become expert in cutting this block and make it very uniform both as to size and quality of dressing. This standard block has enabled the quarries to cut blocks ahead during dull seasons and thus accumulate a good stock so that prompt deliveries have resulted.

Concrete Foundation

In laying a modern granite block pavement a good concrete foundation 6 ins. in depth should be first constructed. This foundation should conform to the finished surface of the pavement and be parallel thereto.

Upon this concrete base a sand or a sand and cement cushion should be spread whose thickness should not exceed 1 in. and then the blocks should be carefully paved in straight courses at right angles to the length of the roadway except at intersections, where they should be placed so that the traffic will cross the long joints. The blocks should be well bedded in the cushion and paved with close end joints and the transverse joints should be as close as possible and yet keep the blocks in straight courses.

NEWLY MADE GRANITE PAVING BLOCKS.

After the laying of the blocks the pavement should be thoroughly rammed and all low blocks carefully lifted out with tongs in order that the adjacent blocks and cushion may not be disturbed, after which more cushion should be placed and these blocks replaced and rammed, after which the whole pavement should be thoroughly back-rammed to an even surface before the joint filler is permitted to be placed in the joints. The lack of proper ramming is one of the most fruitful sources of trouble with a granite block pavement.

The general custom is to sub-let the labor of paving at a square yard price. In this way the general contractor does not have such direct authority over the pavers as though he hired them directly,

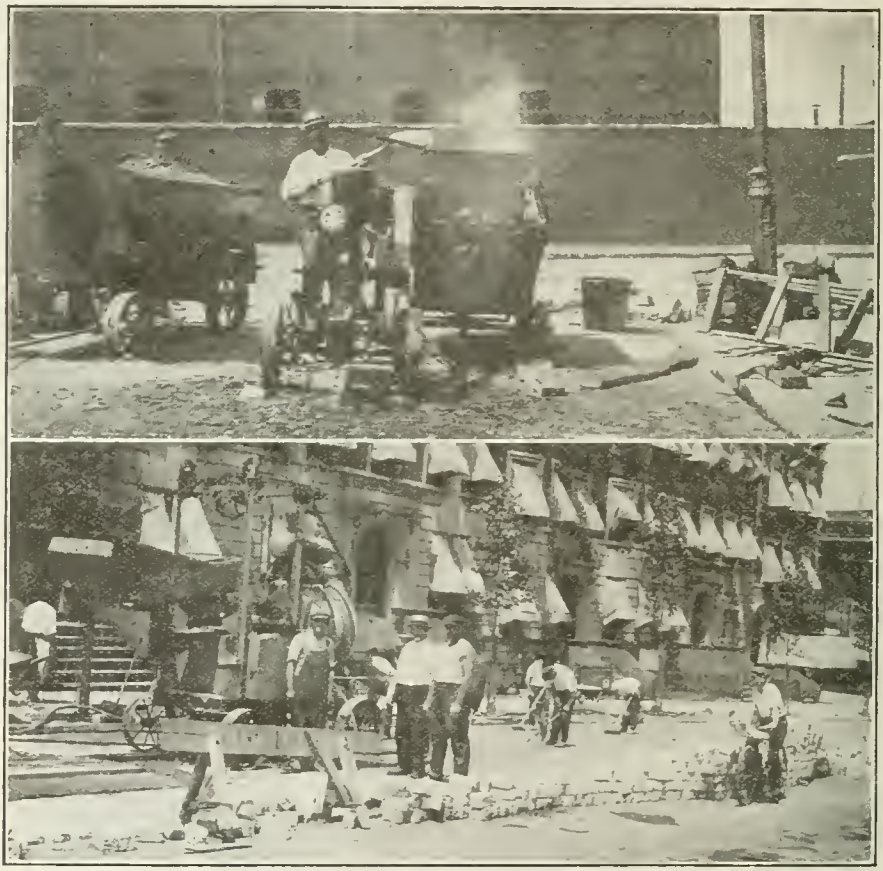
and as a result the sub-contractor will slight his ramming and save the wages of a rammersman whenever possible. The lack of ramming will soon show up after vehicular traffic is permitted to pass over the pavement. This matter of thorough ramming cannot be too strongly emphasized.

Asphalt Filler

The pavement is now ready for pouring the filler into the joints. The best practice is to fill the joints with hot asphalt mastic composed of asphalt and fine hot sand not to exceed 50% of sand. This mixture is flushed over the surface of the pavement and pushed into the joints by means of a squeegee. Care should be taken to get the joints thoroughly filled with the mixture while hot and leave as little of the filler over the surface as possible. After the joints are completely filled, and remain filled, a sprinkling of sand or grit should be scattered over the surface to prevent traffic from sticking to the filler left on the surface. Another good mixture is made of 5 parts of coal tar pitch with 1 part of asphalt which is mixed with fine sand and flushed into the joints in the same manner as previously described for the asphalt filler.

Cement Grout Filler

On streets which may be blocked off for sufficient time to allow a cement grout filler to obtain a proper set and where frequent openings are not likely to be made in the pavement, a cement grout filler of 1 part Portland cement to 1 part of fine sand mixed to the consistency of thin cream in a small batch concrete mixer, and flushed over the surface of the pavement until the joints are filled flush with the surface of the pavement is a very satisfactory filler and makes a first-class pavement. In the case where a cement grout filler is used if the traffic that passes over the pavement is heavy it is sometimes advisable to use a cement



ASPHALT MASTIC (TOP) AND CEMENT GROUT MIXERS USED ON GRANITE BLOCK PAVEMENT CONSTRUCTION.

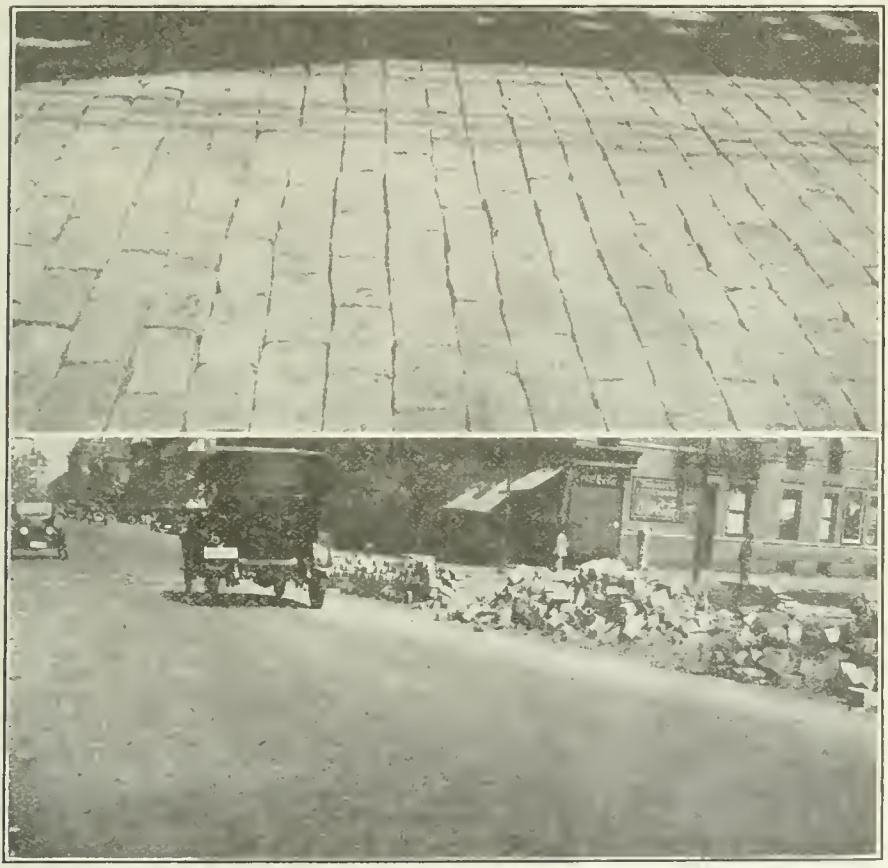
and sand cushion on top of the concrete, mixed in the proportion of 1 part of Portland cement to 4 parts of sand, but in the case where a bituminous mastic filler is used the cement and sand cushion is usually a waste of money unless the traffic is kept off of the pavement until the mortar cushion has had sufficient time to set.

With both an asphalt mastic filler and a cement grout filler it is advisable to use a machine mixer and to deliver the filler directly from the machine onto the pavement in order that there shall be no chance for the sand to settle before the mixture is placed in the joints.

Selecting the Sand

In both cases it is also preferable to use a very even grained sand, as this remains in suspension much better than a graded sand. The best sand for this work is one of which at least 85% will pass a 20 mesh screen. The materials should be carefully measured and not guessed at. In the case of the mastic filler the amount of sand used will vary somewhat with the kind of asphalt and the sand used. It is well to try mixtures varying between 35% and 50% of sand in order to determine which works the best. With a good fine sand and a good asphalt in general about 40% sand usually works most satisfactorily.

As in the case of other kinds of pavements, it is necessary to give careful attention to details in order that the best results may be obtained. The asphalt must not be heated to a temperature that will possibly burn it and the sand must be thoroughly dried and not so hot that it will burn the asphalt when placed therein. When possible to obtain it the most satisfactory sand is obtained from asphalt plants heated in their drums and hauled to the street heated ready to mix with the asphalt.



GRANITE BLOCK PAVEMENT READY FOR JOINT FILLER AND VIEW OF FINISHED PAVEMENT.

Consistency of Cement Grout Filler

When cement grout filler is used great care should be exercised in regard to the proper consistency. The grout should flow readily and yet not be so thin that the water and cement separates from the sand. A mistake often made is that of ramming the pavement again after the first pouring of the grout. By doing this the initial set of the grout is likely to be broken and the filler will then crumble and cause loose or open joints. The ramming should be completed previous to the pouring of any grout. After the grout has obtained its initial set so that the covering of sand or loam will not stick or mix with it, such a covering of half an inch to an inch should be spread over the surface of the pavement and kept moist in hot, dry weather, in order that the grout may obtain a thorough set. No traffic should be allowed upon the pavement for at least 7 days, and preferably 10 days or 2 weeks.

Using a Shallow Block

In addition to the standard granite blocks as described above, some localities use a shallow 4-in. depth block. The advantage obtained by using this block is a saving in freight charges to inland cities having long rail hauls. Another block used to a considerable extent is known as the Durax block, which is a small, approximately cubical block, having faces from 3 ins. to 4 ins. square. These Durax blocks are usually laid in concentric arcs of circles, as in this way the joints are radial. The traffic crosses the joints diagonally and this obviates the disadvantage of the short breakage of joints due to using the small blocks. This method of laying the blocks gives an attractive appearance to the pavement, and with such small units a very uniform surface may be obtained. This pavement is usually laid in a dry mortar cushion of 1 part cement to 4 parts of sand placed upon the concrete foundation. The joint filler is usually asphalt mastic, and the traffic is blocked off until the mortar cushion has had proper chance to set. It has been found advisable to use a light roller upon this pavement previous to the pouring of the joints. The roller is helpful in obtaining a good surface when small units like the Durax blocks are used, but is not satisfactory with the larger blocks such as the standard blocks. In the latter case it is necessary to have the human element of the rammersman as the roller adjusts the high points of the blocks to a uniform surface, whereas in the case of the standard blocks it is necessary to adjust the general surface of the block to the general surface of the adjacent blocks rather than simply the high points.

Napped and Reclipped Block

Another form of granite block pavement is what is known as napped and reclipped block. The old style 7 to 8 in. depth granite blocks are napped or broken and two new heads are made by clipping the newly broken faces to rectangular heads. These blocks should be dressed to the same dimensions as the new standard granite blocks with the exception that the length will be less as the length of the new blocks will be the depth of the old ones. These should be laid in the same manner as the new blocks and with just as much care. There are many examples of napped block used without any recutting. In this case the longitudinal joints are poor because of the more or less rounded heads of the old blocks and soon become rough from traffic, causing ruts to form at these poor end joints. It is a mistake to use the old blocks unless they are cut to good rectangular shaped blocks. The old adage—whatever is worth doing is worth doing well—most certainly applies here.

SUGGESTIONS ON SUBDIVISION PLANNING

By S. G. Swigart, of Swigart & Ehrman, Civil and Hydraulic Engineers, 1118 Second National Bldg., Akron, Ohio.

The subject of subdivision planning has not been given the attention it merits in most of our technical journals. Several books on City Planning have been written, but the subject has seldom been mentioned in any of the engineering journals. The older portions of most of our Eastern cities, especially, and some in the Middle-west were laid out without any definite plan, in fact they "just grew." As the population increased and land became too valuable for agriculture each owner would subdivide a tract of land, quite often irregular in shape, according to his own notions and generally to get the largest number of lots out of it without any regard to adjacent unplatted land at all and often with very little regard to existing streets, drainage and public convenience. The result is a jumbled up system of streets, expensive grading and sewerage and a generally bad appearance. Within the past few years public sentiment has demanded and secured legislation providing for Planning Commissions

and a City Planning Engineer with power to enforce certain regulations regarding the laying out of new subdivistons so that in the future they should be laid out with reference to the public convenience.

Planning Commission and Its Powers.

The Planning Commission should have authority to enforce reasonable regulations within a distance of three or four miles from the city limits and should be composed of practical business men who are posted in a general way on the subject of City Planning and they should employ a thoroughly capable Civil Engineer who is especially qualified for the work. They should require: (1) A preliminary plat showing contours, proposed layout, and adjacent lands and streets. This to be approved or altered according to decision of the Planning Commission. (2) A final plat for record, showing all dimensions, angles, curve data as radii on both center and side lines of streets, central angles, tangent distances, long chords and arcs for total lengths of curves and for each lot, location of all monuments, block distances on street center lines and side and locating building lines. (3) Profiles of all streets on center lines and both side lines and in addition on building lines on both sides. (The above are all necessary for intelligently establishing grades.) Suggested grade lines should be shown on these profiles in pencil, subject to approval or alteration by the City Engineering Department, and (4) Complete plans for sewers and water mains.

Plan.

The plan should take into consideration surface drainage and sewerage, views from building sites, conections with existing streets, traffic circulation especially to important traffic centers, and proper zoning. A point generally ignored is that on residence lots no more than one residence should ever be permitted on any one lot and no lot or lots should ever be resubdivided. This would protect adjoining property owners as to the class of residences and from damage to property values by future owners cutting the original lots into very small lots and building a large number of houses on a small area. Zoning is very important also for the protection of property values and proper and intelligible location of business centers and manufacturing sites and for classification of residence districts according to values, etc. This, of course, is a sufficiently large subject in itself for a good-sized book, but a few suggestions here will probably not be amiss. Small business centers should be located at convenient sites in residence districts and proper restrictions required. The location of such business centers should, of course, be at and near the intersections of the most important streets. These should be limited to groceries, meat markets, drug stores and such small businesses as are needed for serving the adjacent residence districts. The classification of residence districts is also a very important matter for the protection of property values and for the beautifying of the city.

Where restrictions are made in the deeds as to values, etc., this matter is automatically taken care of but the Planning Commission should have authority to regulate such restrictions as individual subdividers may have very different notions and one subdivider may lay out small lots and allow cheap residences immediately adjacent to another very high-class subdivision.

Widths of Streets

Streets should vary in width according to size of lots, class of residences and amount and character of traffic. This is a subject upon which opinions differ widely and I will simply state my own views. There are, in the United States, extremes both ways. We find very wide streets in some of our cities, especially in the West where much narrower ones would not only suffice to take care of traffic, but would be much less expensive to improve and maintain and, on the other hand, we find many streets in our Eastern cities, which are totally inadequate to take care of traffic. The principal business streets of a city, also the main driving thoroughfares and boulevards, should have a width of from 80 ft. to 130 ft., and possibly in some cases 150 ft. The principal residence streets should be from 60 ft. to 100 ft. wide and the minor residence streets, where there is no through traffic should be from 40 ft. to 50 ft. wide. I know that many engineers believe in a minimum street width of 50 ft., but I know of many 40 ft. streets which appear to me ample to take care of all the traffic which will ever come over them. This is especially true of short streets where there is practically no traffic except by the immediate residents, their friends and delivery cars. To require a wider street in such cases places an extra cost for paving and maintenance which seems to me entirely unjustifiable.

As to the proper division of these vari-

ous widths into pavement, lawn and sidewalks, this varies somewhat again according to character of street, amount of traffic, and on residence streets, classification, depth to building lines and whether there are street car tracks. On business streets, with a very heavy traffic, of course, no lawn spaces are required and the total width is taken up by the pavement (including car tracks) and the sidewalks. In such streets the following table gives about the proper width of pavement and sidewalks on each side:

Total Width	Pavement	Sidewalks Including Curb
150 ft.	100 ft.	25 ft.
140 ft.	96 ft.	22 ft.
130 ft.	90 ft.	20 ft.
120 ft.	80 ft.	20 ft.
110 ft.	76 ft.	17 ft.
100 ft.	72 ft.	14 ft.
90 ft.	68 ft.	11 ft.
80 ft.	60 ft.	10 ft.
70 ft.	50 ft.	10 ft.
60 ft.	44 ft.	8 ft.

For residence streets the following table gives the appropriate subdivision of width for pavement, two sidewalks and two lawn strips. Of course, it is not claimed that these will suit all cases, but in general they are as near correct as possible:

Total Width	Pavement	Lawn Including Curb	Sidewalk Each Side
100 ft.	60 ft.	10 to 12 ft.	8 to 10 ft.
90 ft.	56 ft.	9 to 11 ft.	6 to 8 ft.
80 ft.	50 ft.	8 ft.	7 ft.
70 ft.	40 ft.	8 ft.	7 ft.
60 ft.	34 ft.	7 ft.	6 ft.
50 ft.	28 ft.	5 ft.	6 ft.
45 ft.	24 ft.	5.5 ft.	5 ft.
40 ft.	22 ft.	4 ft.	5 ft.

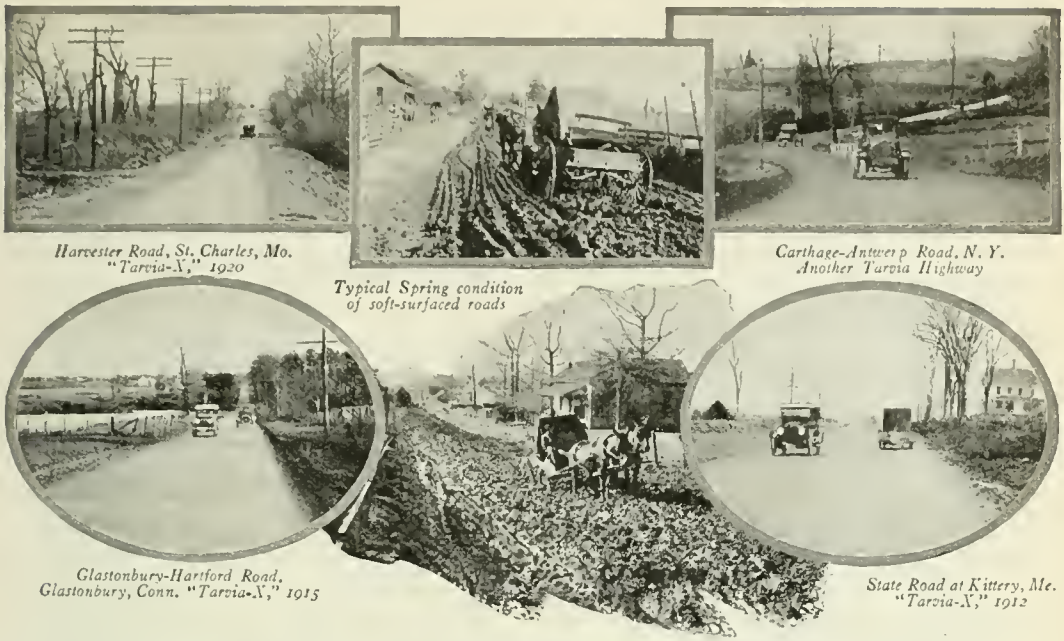
In cases of boulevards and parkways every case is governed by special design. Where there are street car tracks, the pavement should always be wide enough for ample clearance for vehicles on both sides. The crown of the street should vary as the width, sloping on a true plane from the center to both curbs at a rate of from ¼ in. per foot for asphalt or equally smooth pavements to ½ in. per foot for stone pavements, except in narrow streets, where it may slope as much as ¾ in. per foot with stone pavements. On grades over 2 per cent, these slopes should be reduced. Some engineers prefer a curved cross-section in which case the crown at the center should be the same and a circular curve used to fit, the crown being the middle ordinate. The objection to curved crowns is that they are too flat near the center for drainage and too steep near the edges for safe driving. The curb should generally be level with the crown and the lawn should slope ¾ in. per foot and the sidewalks ¼ in. per foot.

Landscape Design for Subdivision.

It is quite common at present for high-class subdivisions to be designed by landscape architects or at least designed with mostly curved streets by an engineer or by a landscape architect co-operating with an engineer. The practice became almost too common in our city during the boom of 1919-20. In many cases, in my opinion, curved streets were laid out where they do not fit the topography and where straight streets really would be better. I do not believe in introducing curves in streets without any good reason from a topographical standpoint. The only good reasons for curves are improvement of view from the street itself and from residences, reducing of grades and improving the scenic effect. One or the other of these reasons is always given as the reason for curves, but in many cases it is pretty difficult to see the point. It should be taken into consideration that curves shorten the view for automobile drivers, increase the danger of skidding when pavements are wet and consequently require slower driving for safety than straight streets. For these reasons they should be avoided on streets where the traffic is likely to be heavy. They should also be avoided in business sections entirely, except at necessary turns or corners and then they should be short. There is no doubt that for parks or private grounds curved parkways and drives are entirely appropriate, but except for the reason given above it is my opinion that they should be carefully avoided. On rolling ground there is sufficient reason to introduce enough curvature to satisfy every requirement of beauty, etc., without locating them where there is no good reason. Where curved streets are laid out, as a general rule, the side lines of the lots should be radial and the buildings should be required to be set so that the front line is a chord of a curve concentric to the street on the building line.

Maximum and Minimum Grades.

Grades for streets should be limited, but not according to any fixed rule. What would seem like a very light grade in some localities would seem excessive in other places. Also what might be too heavy a grade for a through street with heavy traffic might be entirely reasonable for a short street with only local traffic. However, the following may be considered as reasonable limits for grades: For business streets or through traffic streets where all classes of traffic are common



Harvester Road, St. Charles, Mo. "Tarvia-X," 1920

Typical Spring condition of soft-surfaced roads

Carthage-Antwerp Road, N. Y. Another Tarvia Highway

Glastonbury-Hartford Road, Glastonbury, Conn. "Tarvia-X," 1915

State Road at Kittery, Me. "Tarvia-X," 1912

Tarvia transforms old-fashioned mud roads into all-year mudless, dustless highways—

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the grade should not exceed 7 per cent in any case and where practicable the limit should be 5 per cent. For short residence streets where there is only local traffic the maximum limit might be as high as 13 per cent. Of course, on steep grades, smooth pavements should not be used. The minimum limit depends on the kind of surface and should vary from 0.3 per cent to 0.5 per cent.

It is my opinion that it would be wise for planning commissions to require on all new subdivisions that the real estate developer should install all public improvements within a certain specified time and pay the entire cost with no expense to the city. Of course, this would stop many of the subdivisions from being laid out, but it would lead to much more conservative development. It would not interfere with the development of subdivisions in desirable locations or where there is a real demand for them and it would tend to discourage wild-cat speculation and the subdividing of land that should be kept for farming purposes for years to come. Of course, it is not necessary to require as high-class improvements on the cheaper grade of allotments intended for industrial employes' residences, but at least such improvements as street grading, sidewalks, sewers, water pipes and street lighting should be required on these.

It seems almost unnecessary to say that subdivision work, in all its phases, is strictly a civil engineer's job and should be entrusted to competent civil engineers only and yet there are many of our subdividers who entrust such work to men who would be unable to qualify as rodmen with first-class engineering organizations. While experience generally teaches them the folly of this it is almost always after a great deal of damage has been done and sometimes after the work has reached such a stage as to make it practically impossible to remedy it. I have often said that poor engineering and surveying work is not only not worth anything, but is an actual damage.

PRESERVING SAND-CLAY, GRAVEL AND TOP SOIL ROADS IN NORTH CAROLINA

In the consideration of the problem of how to preserve and derive the maximum service from its top soil, sand-clay and gravel roads, the State of North Carolina has something in common with many other States, having large mileages of these types of roads which now demand some form of treatment to protect them from the disintegrating effects of modern traffic and the elements.

It is generally recognized that the best results are to be obtained through the application of a bituminous material. However, many states and counties have encountered the same difficulty experienced by the North Carolina State Highway Department. This Department has found that a material light enough to penetrate the sand-clay, top soil or gravel surface does not have binding quality, and on the other hand it was developed that a material which did have sufficient binding quality was too heavy to penetrate the road. In the case of the heavy treatment, the bituminous material went into the formation of a mat on the surface of the road, and the bond between the road and the bituminous mat was eventually destroyed by the dusting up of the surface beneath the mat. The weakness in this treatment was not in the bituminous blanket but in the contact between the bituminous blanket and the road surface.

Undoubtedly this has been the experience of many of the other states having large mileages of these types of roads, and the experiment being conducted by North Carolina will be of interest and value.

The sand-clay, top soil or gravel surface is first softened by sprinkling, and then a single layer of broken stone or gravel of approximately 1½ ins. in size is rolled into the surface. After giving the surface time to dry out, and in order to secure maximum consolidation, the roadway is opened to traffic for a short period, after which it is swept clean by brooming.

The road then presents an ideal surface for treatment with an asphaltic material, one to which a material possessing the desirable binding qualities may be applied without danger of being separated from the road surface by the dusting up of the surface as a result of the impact of traffic.

The North Carolina State Highway Department has been using Texaco No. 55 Road Oil in its experiments, and while the new construction has not been subjected to traffic long enough to say that it has proven absolutely satisfactory, it is anticipated that the result of the experiment will be to produce a waterproof, durable and resilient mat which will add considerably to the efficiency and life of sand-clay, top soil and gravel roads.

WATER WORKS SECTION

MOTOR DRIVEN CENTRIFUGALS WITH GAS ENGINE STANDBY

By W. B. Bushnell, Supervising Engineer, Champaign & Urbana Water Co., 18 Taylor St., Champaign, Ill.

Prior to 1917, the Champaign and Urbana Water Company generated all the power required for the operation of its pumping equipment.

During this year, however, it entered into a contract with the Urbana and Champaign Railway, Gas and Electric Company to purchase all the electric power it required from them. This decision was reached principally because of the following conditions:

1. The power company offered to enter into a contract to furnish electric power at rates which very closely approximated the cost at which the water company was producing it.
2. The signs of the times indicated that the future source of cheap power was likely to be from large generating stations which transmitted and distributed the power over extensive territories.
3. The water company would in a comparatively short time be compelled to install additional electrical generating equipment in order to meet its demands.

A contract was entered into and a connection was made to the Urbana and Champaign Railway, Gas and Electric Company power plant. About the same time another connection was made to the power plant of the Urbana Light, Heat and Power Company. This latter connection is used only in case of failure of the supply from the former company.

The water company continued to maintain as a standby unit one 2,500,000 gals. per day Laidlaw-Dunn-Gordon steam service pump. It also maintained in service as standby equipment a 200 KVA generating unit which was of sufficient capacity to generate the power necessary for the operation of its well pumps. These gave an additional assurance of the continuity of water service. The service was maintained in this manner until 1921 when the demand on the water company's plant became sufficient to require the installation of additional service pumps.

It was necessary, at this time, to put into operation all of the motor-driven pumps in order to furnish adequate fire pressure. The regular domestic service was then supplied by two 1½ MGD centrifugal pumps which could be operated either in parallel or in series. During a certain portion of the day both these pumps were required to furnish domestic service. It was therefore decided that any additional units should be of 3 MGD capacity.

This company had had quite a lengthy experience with reciprocating steam pumps and about seven years' experience with motor driven centrifugals. In the light of its experience it was an easy matter to decide that any additional pumping equipment should be of the centrifugal type.

By this time the demand had reached a point at which the Laidlaw-Dunn-Gordon steam pump was inadequate to carry the load in case of total failure of the supply of purchased power. It was, therefore, decided that additional standby equipment should also be supplied.

The Equipment.

To meet the combined need of equipment for normal operations and for standby service, two centrifugal pumping units were installed, each consisting of:

One 8-in. single stage, double suction DeLaval centrifugal pump connected at one end through special jaw coupling to one 145 H. P. model FC-6 Sterling gasoline engine, and at the other end through a flexible coupling to a type KT-General Electric, 3-phase, 60-cycle, 220-volt squirrel cage motor with starting compensator.

The pumps were designed to deliver 2,100 g. p. m., against 127 ft. total head, having a guaranteed efficiency of 78 per cent at speed of 1,160 r. p. m., and to permit of operation either in parallel or in series. When the pumps are driven by the gasoline engine the motor rotors are allowed to float.

On March 22, 1921, when the two units were put into operation there became available for stand-by service a total domestic service capacity of 8½ m. g. d., or a total fire service pumping capacity of 5½ m. g. d. The 200 KVA generator was continued in operation so that the

plant was in a position to maintain continuous service under extremely adverse circumstances.

Installation Features.

Some interesting features in connection with the installation and operation of these units will be briefly given below.

The pumps were set at right angles to each other, a position necessitated by the available floor space, and it is of interest to note that had the same pumping capacity been provided by means of steam pumps an addition to the pumping station building would have been necessary.

These pumping units have a common suction line which is 18 ins. in diameter and 180 ft. in length to the point at which the nearest pump obtained its supply. The pumps may be thrown in parallel or in series by means of hydraulic valves. The small valves which control both hydraulic valves are in one place so that their joint operation is quite easily accomplished.

There was quite a little difficulty experienced in setting these pumps which might have been eliminated had there been one or two flexible connections in the pipe lines instead of being all of rigid flange connections.

The gasoline supply for the engines is stored in two tanks of about 60 gals. each, buried in the ground outside the building. The gasoline is forced to the engines by means of air pressure created by an air pump which operates to fill a storage tank which may be made to feed into the gasoline tanks. The gasoline piping is so arranged that either one of the tanks may be drawn from and it is the practice to keep one cut out at all times so that should the engine stop from lack of gasoline a full tank will be available and warning given that the other tank should be filled. The combined capacity of the two tanks is sufficient to operate both engines at full load for about five hours. A Standard Oil station is within two blocks of the plant and arrangements have been made with the attendant whereby it is possible, in case of necessity, to obtain gasoline at any time of day or night. For this reason it is deemed sufficient to carry a maximum supply sufficient for five hours' run under fire service conditions.

The exhaust from the engines is carried outside of the pumping station building and there passes through Maxim silencers, which very efficiently perform the duty for which they were designed. In fact, the noise from the exhaust is barely audible for a distance of a couple of hundred feet. This is somewhat in contrast with the noise of the running engines within the building which is especially noticeable because of the quiet operation of the motor driven centrifugal pumps. However, this is not an especially objectionable feature for stand-by equipment, due to the comparatively short duration of time that they are called into service.

The gasoline engines are equipped with self-starters and generators for charging the storage batteries required for same. The generator is regularly installed from the shaft geared to the main shaft of the engine. This arrangement would, no doubt, be quite satisfactory for an engine which did not start often and then ran for quite a period of time. These engines, however, are started twice a day and run only a few minutes at low speed for testing. Under these conditions it was found that the batteries were not maintained in a charged condition. For this reason the generators were placed so that they might be operated by the shaft on the motor side of the pump. In this manner the charging may be continued during the normal operation of the pumps.

There has been but one occasion upon which these engines have refused to start and this could be traced to the use of a poor grade of oil. Upon investigation at this time it was found that the spark plugs were so badly carboned that it was surprising that the engines had not refused to start long before. The trouble was eliminated by using a different grade of oil.

Some investigation has been made of the storage batteries. It was found some time ago that they had reached a point where all the cells could not be charged as they should. The results of the investigation were that the starting current for the first second or two was 130 amps. and then dropped to 80 amps. As these batteries are of 50 amp.-hr. capacity it will be seen that under the nature of service they are required to perform, they are called upon to stand quite a little abuse. Batteries of sufficient size to perform this service without being abusive would necessarily be quite large and cost a considerable sum. It was, therefore, concluded that it would be better to use batteries of the present size as long as they would perform the work required of them and then buy new ones about the same size.

The normal pumpage during the greater part of the day is taken care of by one of these pumps. When it is necessary to

furnish fire pressure these two pumps are thrown in series as well as other pumps. In the process of throwing these pumps in series, at a time when the water in the reservoir is below the pump suction, it is possible to manipulate the control valves so that one pump will lose its suction. This can be prevented by proper opening and closing the valves in proper order, but we found upon one or two occasions the valves were not properly operated. In order to provide a quick remedy for human error in this regard a No. 0 Nash vacuum pump was installed so that it is driven from pulley in the shaft of the pump. By means of this the prime can be regained in somewhat less than a minute.

From the experience of operating these units for the past year we are of the opinion that the gasoline engines provide a very satisfactory method of providing stand-by power.

The foregoing paper by Mr. Bushnell was presented at the recent annual meeting of the Illinois Section of the American Water Works Association.

THE CONSTRUCTION OF THE LOCH RAVEN DAM OF THE BALTIMORE WATER WORKS

By Wm. A. Mcgraw, Water Engineer, City Hall, Baltimore, Md.

Baltimore is engaged in making what is known as the Gunpowder improvement to its water supply. The plans include a dam at Loch Raven on the Gunpowder river to impound 23 billion gallons of water, and a balancing reservoir to limit the pressure on a 7-mile tunnel conducting water to the city, together with the necessary relocation of roads and bridges, the purchase and removal of the villages of Warren and Phoenix, the relocation of 1.5 miles of Pennsylvania Railroad tracks near Phoenix, the purchase of about 4,000 acres of land from 54 different owners and clearing the ground to be flooded of buildings, trees and vegetable matter.

The principal feature is the Loch Raven Dam, which is nearing completion. Plans were first prepared in 1913 and the work completed during the following year to elevation 188 ft. above mean tide, the base being made broad enough to support the additional section necessary for raising the dam later to elevation 270. The plans, under which the present contract is proceeding, provide to raise the dam from elevation 188 to elevation 240. The dam is a solid concrete structure, 640 ft. long over all. The spillway is 288 ft. long and raises about 103 ft. above bed rock.

Allowing for Upward Pressure

In designing the cross section, upward pressure was assumed on all horizontal joints, equal to the full hydrostatic pressure at the upstream face, decreasing to zero at the downstream face. Porous drains in the horizontal joints, which will be described later are provided to relieve upward pressure. Two 48 in. pipes passing through the old foundations control the ordinary flow of the river and enabled all concrete to be deposited on dry surfaces. One in. bent steel rods, 5 ft. apart horizontally and vertically, imbedded 3 ins. back of the down-stream face, can be straightened to assist in binding the new concrete to the old, in case the dam is ever raised to a higher elevation.

The gate chamber is divided into two separate compartments and each is designed to supply the city separately. Fifteen sluice gates, 3½ ft. by 6 ft., arranged at different heights, control the entrance of water.

Transportation Arrangements

The dam is located between steep hillsides and the available working space is small. Stone was furnished from a city quarry located on the west side of the river 3,000 ft. down stream from the dam. An improved highway extends from a point on the hillside opposite and above the dam down to and past the quarry to Loch Raven Station on the Maryland and Pennsylvania Railroad about 2,200 ft. farther down. Loch Raven Station is about 11 miles from Baltimore. The railroad at Loch Raven Station is approximately at right angles to the river and follows along a steep hillside about 50 ft. above the highway, which turns and parallels the railroad in both directions. A siding about 1,600 ft. west of the railroad station provides a means of handling materials from the railroad by gravity to the highway below. An old city-owned siding 1.6 miles long is located on the west side of the river and extends from the dam southerly to a point where the railroad, 1.2 miles east of Loch Raven Station, meets it at grade. This arrangement of highways, railroads and sidings, offered several means of handling the work of construction.

The contract was awarded to the Whiting-Turner Construction Company of Baltimore on April 6, 1921, and about July 1 the first concrete was deposited. The bulk of the work was completed by January 1, 1922.

Chuting System

The specifications permitted the use of cyclopean concrete, but the contractor installed a chute system for distribution, which precluded the depositing of large stones, except in the east shore section, where a derrick, used for excavating the east abutment, swung a portion of the larger stones into the dam. The chute system was designed by the Lakewood Engineering Company.

On the west of the river, the topographical conditions were ideal for a gravity plant. The contractor, availing himself of this advantage, located his crusher, storage bins and mixing and distributing plant up and down the west hillside just south of the site for the dam, although the city siding on the opposite side of the river connected the dam directly with the main line of a railroad.

Handling Cement

Cement was the only material hauled by railroad. On the hillside below the siding at Loch Raven Station, a cement house was built with a capacity of 5,000 bbls. The cement was here received in bags and handled by a belt conveyor operated by a gasoline engine which also operated a bag shaker consisting of a wire cage rotating about 7 minutes for each charge. By means of a chute the bags of cement were passed to trucks. The trucks transported the cement to a 200 bbl. capacity shed located on the hillside above the plant, whence it was conveyed directly to the mixer platform by chutes.

Working Sand Pit

The neighborhood sand is generally not suitable for concrete, but the contractor was able to locate an excellent sand pit about 2 miles from the dam. The cost of sand at the pit was 24 cts. per cu. yd. and the cost of trucking 44 cts. per cu. yd., making a total of 68 cts. for the sand delivered. The quotation for river sand shipped from Baltimore was 70 cts. per ton plus $1.14 for freight, which is the equivalent of $1.45 per cu. yd. The contractor was thus saved 75 cts. per yard and the delays consequent to rail shipment.

The sand was excavated by a ¾ yd. revolving steam shovel and transported by motor trucks to a point above the plant and dumped directly into a hopper at the elevation of the highway, from which a belt conveyor carried it to two large storage bins, one of which is located on each side of the stone bin. The total capacity of the two bins is 500 cu. yds.

The sand contained a maximum of 10% of clay which was twice the amount authorized by the specifications. It was accepted only after thorough tests were made. One to three mortar briquettes showed an average of 250 lbs. per sq. in., which is 50 lbs. above the standard requirement. At different times, as the work progressed, 4 in. cubes were made from concrete as it passed from the chutes into the dam. The compressive strength of these cubes at the end of 28 days averaged 1,800 lbs. for 1-3-6 concrete and 2,220 lbs. for 1-2-4 concrete. The sand was well graded from small to large and contained a considerable percentage of gravel for which reduction was made in the stone. The clay seemed to lubricate the concrete, causing it to be more easily mixed, chuted and worked. The concrete produced a smaller amount of laittance than is usual and honeycombing is almost entirely absent from the dam.

Quarrying Stone

The stone was taken from the city quarry with no expense other than that of actual quarrying. For each blast, two large well drillers were used to put down about 10 holes 12 ft. apart and 85 ft. deep, located parallel to and 20 ft. back of the quarry face. Three large blasts, each requiring about 4,200 lbs. of dynamite, made at different times as the work progressed, were required to throw down the necessary 45,000 yds. of rock. After each shot considerable secondary drilling was done by various kinds of drills, and tripod and jackhammer, besides a large amount of mud capping, in order to reduce the stone to steam shovel size. The air used by the drills was piped from the power plant located below the dam. A ¾ yd. Erie shovel used at the beginning of the job soon proved insufficient and was replaced by a 90 ton Marion shovel for loading the stone into dump cars.

Crushing Stone

The cars were hauling a half mile to the dam over a 36 in. gauge track by an 18 ton dinkey, 4 cars constituting a train. As the track approached the dam, it was elevated on a trestle at 5.8% grade and dumped directly into a 1,500 ton gyratory crusher. A hoisting engine was used to spot the cars up the incline to the front of the crusher, which enabled the locomotive to return for another train while the first trainload was dumped and crushed. From the crusher the broken stone was raised to an overhead bin by means of a belt conveyor. The stone bin has a capacity of 1,000 cu. yds. and is located between the two sand bins.

Mixing Concrete

Water for the concrete is taken from

the river above the dam and measured by two barrels pivoted on their centers and so placed that each will empty into a mixer by hand. Each barrel has a 2½ in. quick opening valve and a mark on the inside to indicate the quantity of water desired.

The sand and stone bins each discharge through a separate chute to a hopper located over a concrete mixer, the hopper being calibrated to measure the quantity of sand and stone required for one batch of concrete and designed to dump all material simultaneously into the mixers. Two 1-yd. mixers have been used: a Smith tilting mixer and a Ransome non-tilting mixer. For work of this character, it developed that the Smith tilting mixer gave better results than the Ransome non-tilting mixer.

The concrete is elevated from the mixers by buckets operating inside of a double wooden tower 204 ft. high and distributed by chutes to the desired points. The concrete buckets are raised by engines, one for each bucket, located at the elevation of the highway about 75 ft. above the bottom of the lower pit.

Expansion Joints

The dam is built in 60 ft. lengths, seperated by transverse expansion joints extending continuously through the cross sections; 5/16 in. by 12 in. vertical steel plates, placed 18 ins. back of the up-stream face, are intended to seal the expansion joints. The up-stream face of the dam is composed of 1-2-4 concrete placed in 8 ft. lifts alternately 6 ft. and 7 ft. back from the face. The remainder of the section is composed of 1-3-6 concrete. The following concreting procedure generally was followed:

Placing Concrete

First, a lift of 1-2-4 concrete, 60 ft. long between expansion joints was deposited. After twelve hours, the forms were removed and 1-3-6 concrete was then deposited in one operation from the back of the 1-2-4 concrete to the down-stream face and for a full length between expansion joints. The 1-3-6 concrete was generally brought 1 ft. higher than the 1-2-4 concrete. The two grades of concrete thus break joints both horizontally and vertically and the only vertical joints, except the expansion joints, are those between the two grades of concrete.

Six inch by 12 in. horizontal bonding grooves, 2 ft. back of the front face and a 14 in. by 14 in. porous block drain 2 ft. further back from the face were placed in the 1-2-4 concrete at the completion of each lift. The bonding groove and groove for the tile drain were cut out by hand as soon as the concrete had sufficiently hardened. The ends of the tile drain are covered with burlap dipped in tar, and the space between the tile and groove filled with dry sand. At each expansion joint, the porous drain enters a 3x3 ft. well, extending vertically upward and downward to galleries respectively above and below the highest and lowest horizontal joints, by means of which inspection can be made of the seepage through the dam. The lower gallery is drained into the tail water on the downstream side. Vertical bonding grooves 2 ft. wide by 7 ft. deep and 10 ft. apart, bond the masonry across the expansion joints.

Supporting Forms

The 1-2-4 concrete originally specified for the downstream face was omitted and 1-3-6, deposited as described above, was substituted. The placing of forms on the downstream face presented a problem. There was no way of supporting them from the interior without leaving considerable timber in the concrete, and supporting them from the outside would have been expensive. The problem was solved by wiring the forms to dowels inserted in the existing concrete. A few props held the forms in place ready for pouring. As the concrete was deposited, the pressure soon became sufficient to keep the forms from collapsing, and the props were then removed. It was necessary to drill holes in the old foundation concrete, for the dowels, but above that elevation, at the end of each day's pour, as soon as the concrete had set sufficiently, pieces of scrap pipe were put in place to serve as dowels.

Installing Gate Valves

In the gate chamber one 24x24 in. and eleven 6-ft.x3.5-ft. gates were placed. The specifications provided that all gates be securely blocked and fastened in position before concreting. The gates will be operated by stems varying in length from 50 ft. to 75 ft. and were required to be set exactly plumb; but as each gate weighs 4,700 lbs., it was practically impossible, with the means available, to sustain them in place while concreting around them. In construction, therefore, the bolts for the gate frames were set as the concrete was deposited and the gates and gate frames were set after concreting of the gate chamber was completed.

The rock stratification on the east hillside is so much inclined from the horizontal that it was impossible to expose a large face without causing a rock slide. It was possible, however, by stepping the

foundation to keep a rugged wall of rock against which to place concrete. About 2,000 yds. of solid rock was estimated, but owing to the sliding tendency, over 5,000 yds. were excavated. Excavation for the east abutment was started before completion of the construction plant, yet, due to the difficulties encountered, this portion of the dam was the last completed.

In order to convey concrete from the mixers on the west side of the river to the easterly part of the east abutment, the concrete was rehandled at the east tower. An elevator bucket within the tower was filled from the line chute, then elevated, and the contents emptied into a second chute higher on the tower. The east tower is 168 ft. high and the west tower 204 ft. high. The towers are 340 ft. apart and connected by a 1½ in. cable which carries the concreting chute.

Causes of Time Losses

The capacity of the plant is about 600 cu. yds. of concrete per 10 hour day, although at times 700 cu. yds. have been placed in the same time. The average per working day was 300 cu. yds. A considerable portion of the contractor's plant had been used before, but the loss due to breakdowns was not excessive. The records of the resident engineer show a loss of 483 working hours. Of this time 48% was due to breakdowns and other troubles with the mixers, 22% due to changing and clogging of chutes, 14% due to accidents in the towers and 15% due to lack of forming space and other causes. On the whole the work progressed with raptdity, which was due in part to the hearty co-operation between the contractor and the engineers.

The Contractor's Equipment

1—Marion 31 revolving steam shovel.
1—Erie type "B" revolving shovel.
1—Marion 61, railroad type, steam shovel gasoline pumping outfit.
1—18-ton Vulcan narrow gauge dinkey.
1—14-ton American narrow gauge dinkey.
10—Koppel 4-yd. dump cars.
10—Western wheel scraper 4-yd. dump cars.
1—325-cu. ft. Ingersoll-Rand steam driven air compressors.
1—160-cu. ft. Chicago Pneumatic Tool air compressor.
1—Bull Dog 20-in. gyratory crusher—rated capacity, 1,500 tons 10 hrs.
1—175-h.p. horizontal Corliss valve steam engine, driving crusher.
1—24-in. rock bucket elevator.
2—20-in. belt conveyors—1 driven by 12-h.p. vertical steam engine, and 1 by 12-h.p. Otto gasoline engine.
1—Link belt sand washer.
1—Steam driven duplex pump, 6-in. suction, 5-in. discharge, for general water supply.
2—Duplex boiler feed pumps.
1—15,000-gal. wooden tank for water supply.
1—150-h.p. locomotive type boiler.
1—150-h.p. Scotch marine boiler.
1—60-h.p. vertical boiler.
1—30-h.p. vertical boiler.
1—Ingersoll-Rand drill sharpener, air operated.
1—Circular saw.
1—Band saw.
1—Grinder.
1—Power-operated pipe-threading machine.
1—Contractor's equipment 7½x10 double drum hoisting engine with boiler.
1—3-drum, 8x12 Munday hoist with boiler.
1—8¼x10 double drum Lidgerwood hoist with boiler.
1—8x10 Lidgerwood hoist with boiler.
1—5x8 double drum hoist with boiler.
1—7x10 American double drum hoist with boiler and boom swinger.
1—8½x10 double drum Lambert skeleton hoist.
1—6½x12 double drum Mundy hoist.
1—Stiff-leg derrick 15-ton capacity with 65-ft. boom.
1—Stiff-leg derrick 15 ton capacity with 60-ft. boom.
1—Stiff-leg derrick 5-ton capacity with 50-ft. boom.
1200 Linear feet of Lakewood chutes.
2—No. 3½ Keystone well drills.

About 45,000 yds. of concrete are required under the present contract, and the cost of all items will amount to about $525,000. The principal unit prices are as follows:

Loose Rock Excavation..	$ 4.69 per cu. yd.
Solid Rock Excavation...	6.67 per cu. yd.
Concrete for Balustrades.	20.60 per cu. yd.
1-2-4 Mass Concrete.....	11.85 per cu. yd.
1-3-6 Mass Concrete.....	10.34 per cu. yd.
Steel Reinforcement	.04¾ per lb.

A total of 50,800 cu. yds. of 1-2.5-5 and 1-2-4 concrete were placed under a previous contract, the cost of all work under which amounted to $527,000. The total cost of the dam from bottom to top is, therefore, $1,052,000.

The writer is indebted to Mr. C. K. Allen, Resident Engineer, for a portion of the information contained in this article.

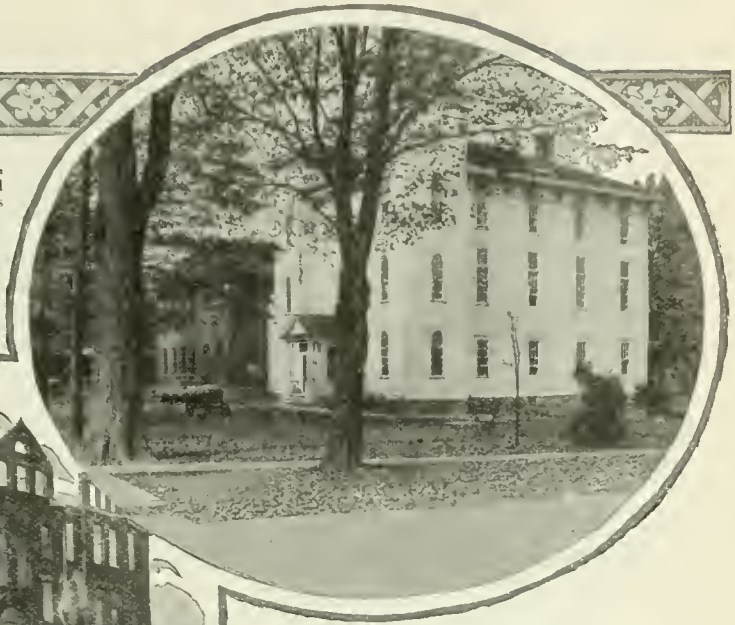
The foregoing paper by Mr. Megraw was presented at the recent annual convention of the American Water Works Association.

COMBINATION OF THE LIME-SODA AND ZEOLITE WATER SOFTING PROCESSES

To the Editor: The testimony in favor of the Centralized Softening of a Public Water Supply, as set forth in your March and April issues, seems to be unanimous. It is difficult to see how contradictory evidence on this subject can be produced.

Your fourth question, with respect to a choice of methods, has brought from Mr. Charles P. Hoover of Columbus, Ohio, the outline of one of the most promising methods, namely, the combination of the lime-soda and zeolite softening processes.

However. I cannot agree with Mr. Hoover that a residual hardness of 85 parts per million is to be considered satisfactory. As a result of more than 20 years'



Three story wood school building at Arcade, N. Y. Heated by waste steam from the town's electric light plant.

The daily press tells us repeatedly of hazardous school fires from forced heating systems.

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Use Community Heating

Ask for Bulletin No. 20-M E on "Adsco Community Heating." Bulletin No. 158-M E describes "Adsco Heating," the One Valve System for individual buildings. Name of your architect appreciated. Architects, engineers and heating dealers should also write for Bulletin 159-M E.

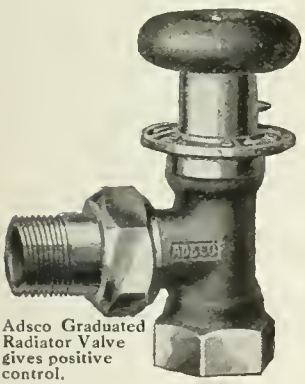
THIS school building had six separate furnace fires in the basement, and the top floor could not be occupied due to existing fire hazards.

Now there are no fires in the building and the top floor is safely used. Heat is supplied by exhaust steam piped through an underground main from the municipal power and lighting plant. The old radiation and piping were used.

Steam, easily regulated as required, is now charged for by meter in the same way as gas, water or electricity.

This is but one instance where a school house was made safe. During the past forty years we have designed and installed Adsco Community Heating Systems in more than 400 towns, institutions, industrial plants, groups of residences, also groups of city office buildings. Steam for heating is supplied from Central Station Plants, either new or old, and is piped to the various buildings through underground mains. The success of these systems has been largely dependent on the specialties and insulation we have perfected to prevent leakage and waste.

Write for complete information regarding cost, operation, profits of Adsco Community Heating.



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experience in designing, building and operating water softeners, I would say that this limit is too high. Few satisfied users who operate their own lime-soda plants are content with a hardness of less than 50 parts per million. Many attain a lower hardness. These and others will gradually become dissatisfied with a 50 parts limit as soon as the possibilities and advantages of softening to appreciably lower limits are realized.

While no doubt many of the early water softening installations have given rise to some annoyance owing to after-precipitation in mains and service piping, later developments in water softening have rendered practical the elimination of such difficulties. No municipality should hesitate to install a softening plant because of the fear that after-precipitation will accumulate in the pipes. At least three methods of correcting any trouble of this sort are freely available to any who would apply them. Very truly yours,

L. M. BOOTH,
President, The Booth Chemical Co.
Elizabeth, N. J., April 29, 1922.

LIGHTING THE MIAMI, FLORIDA, CAUSEWAY

By E. T. Austin, Lighting Specialist, General Electric Co., Schenectady, N. Y.

The causeway joining Miami, one of Florida's leading cities and a winter resort of nation-wide fame and popularity, with its sister community of Miami Beach, is now lighted throughout its entire extent by G-E Novalux highway lighting units. The result is that this stretch of roadway, over which cars sometimes pass at an average rate of 1,000 per hour, with the consequent discomfort and sometimes danger which such congestion means, now offers safe and comfortable motoring conditions.

Built by Dade County several years ago, this causeway is approximately 3½ miles long. One side is given over to the use of trucks, the other to more rapidly moving vehicles, and the center to trolley car tracks. The congestion of travel over it is apparent from the fact that a recent tabulation showed that on one day, between 7 o'clock in the morning and 7 o'clock in the evening, 12,410 automobiles entered and left the city over this thoroughfare—an average of more than 1,000 per hour.

The desirability of lighting the causeway to remedy the danger of driving over it by night was recognized, and efforts were made several years ago to provide an illumination system for it. It was found, however, that with the equipment then available for the purpose the expense both of installing and maintaining a system that would furnish adequate lighting would involve a large sum.

Hence the improvement remained in abeyance until Mr. R. I. Ellis, manager of the Miami Beach Electric Company, learning of the success of the G-E Novalux Highway unit in one of its early installations, obtained several of the fixtures and installed them on the causeway. So effective was the lighting they provided and so easily and safely could cars be driven at night after they were placed, that Mr. Ellis and the Miami Beach Chamber of Commerce laid the matter of lighting the entire causeway before the County Commissioners of Dade County, in which county both communities are located.

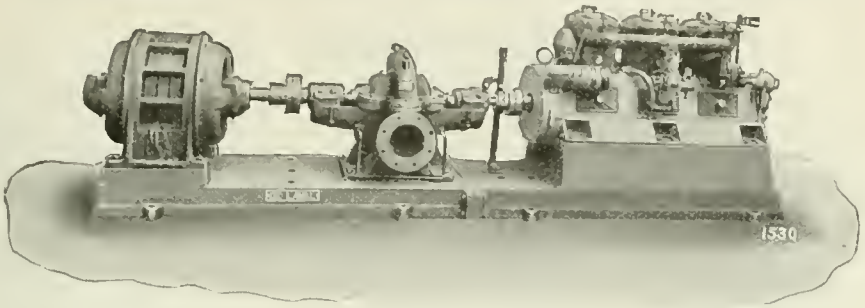
The county commissioners immediately authorized the purchase of 45 more units, which were received and installed within two months. They were mounted on pole extensions which places them 30 ft. above the roadway, and spaced at intervals of 400 ft. except on curves, where the spacing is 300 ft. Each unit is equipped with a 250-candlepower, 6.6 amp. Mazda "C" lamp. The maintenance expense of the system, based on a fixed charge per lamp per year, is assumed by the two cities, Miami paying two-thirds and Miami Beach one-third.

The intensity of the light given by these units is such, and its distribution is so even, that motorists are able to drive over the causeway at 30 miles an hour without head-lamps.

The fixture used for this installation—the Novalux highway lighting unit—is the same as that employed in lighting Paradise Road, Swampscott, Massachusetts; the Albany-Schenectady highway; roads in the vicinity of Detroit, and elsewhere, and which it is proposed to install on the Ideal Section of the Lincoln Highway, in Lake County, Indiana.

Miami is visited annually by thousands of tourists, a very large percentage of whom are keenly interested in highway improvement and in whatever will make motoring safer and more comfortable. They represent every section of the United States, and various foreign nations. Hence this installation is of especial interest, as it affords an opportunity for motorists from far and wide to see for themselves the value of highway lighting.

Duplicate Power Supply for Pumping



THE eight-inch De Laval centrifugal pump shown herewith is arranged to be driven either by an induction motor or, when electrical power is not available, by a 6-cylinder, 100-horse power gasoline engine. A clutch is provided for disconnecting the engine when not in use. The unit is rated at 2100 gal. per min. against 127 ft. head at 1160 r.p.m. With a duplicate power supply there is practically complete assurance of being able to deliver water at all times. The characteristics of De Laval centrifugal pumps are ideal for such service, as there is practically zero starting torque, and, due to the power-limiting charteristic, the De Laval pump cannot possibly overload the motor.

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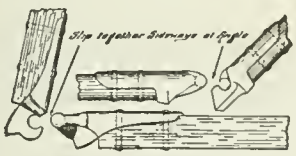

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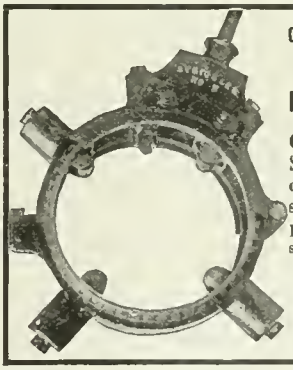

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Construction News and Equipment

NEW ARRANGEMENT OF EQUIPMENT ON CONCRETE ROAD CONSTRUCTION

A complete material handling unit has been worked out by the Portable Machinery Co., of Passaic, N. J., consisting of their contractor's type Scoop Conveyor, specially designed to handle abrasive material, a portable measuring hopper and an auto dump truck. This outfit handles all the materials this side of the concrete mixer and cuts the usual shovel and wheelbarrow gang by 10 or 12 men and keeps the mixer operating at full capacity.

Referring to the accompanying sketch diagram, the stone and sand is first placed in suitable piles along the roadway. One conveyor with a measuring hopper is assigned to the crushed stone and a duplicate outfit is assigned to the sand and cement. Both measuring hoppers are adjustable in size in order to provide for mixtures of different proportions.

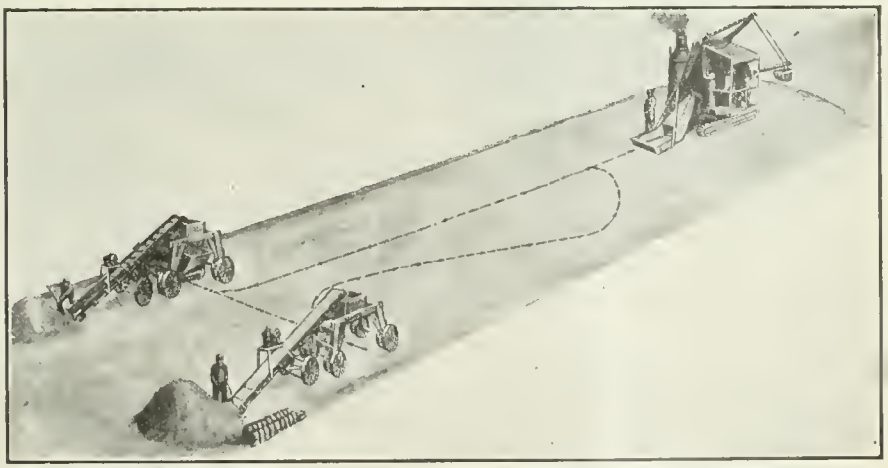
The man in charge of the stone handling outfit fills his hopper with the desired proportion of stone and the man in charge of the sand and cement handling outfit fills his hopper with the correct proportions of sand and cement.

After the measuring hoppers are charged, the dump truck operator drives under the stone hopper and receives the charge of stone, after which he drives under the sand and cement hopper and draws these materials on top of the stone. The load is then driven to the concrete mixer and discharged into the mixer hopper, and by the time the driver comes back to the measuring hoppers, they are filled and ready to discharge their next load. It will be seen that this method of handling provides an unusually flexible arrangement.

The conveyors and measuring hoppers are easily moved backward or kept in close contact with the piles of material scattered along the roadway.

On large jobs it is advisable to use more than one auto dump truck, especially if a speedy concrete mixer is used or if the mixer and measuring hoppers become located far apart.

On small jobs, one conveyor, one hopper and one truck can be used. In this case the stone and sand should be placed close together along the roadway, so that both materials can be fed into the same conveyor. One man is required to feed the stone to the conveyor and a second man to feed the sand and cement. The man handling the sand, feeds a certain number of shovelfuls to the conveyor, after which he stops and adds the cement, while the man feeding the stone continues feeding until



SKETCH SHOWING USE OF PORTABLE BELT CONVEYORS, MEASURING HOPPERS AND MOTOR DUMP TRUCKS ON CONCRETE ROAD CONSTRUCTION.

the hopper is full. If desired, the cement can be added at the mixer skip.

The ideal outfit is two conveyors, two mixer hoppers and two auto dump trucks. This provides a double unit, and if anything goes wrong with any part of one unit, the second unit will always keep the mixer going.

Again, it may be desirable, at certain intervals, to use one of the conveyors to handle stone or sand from railroad cars or from storage piles to the trucks that must first convey these materials to points along the roadway. Both the conveyors and measuring hoppers are manufactured in various sizes by the Portable Machinery Company, of Passaic, N. J.

A NEW ROAD REPAIR HEATER

A portable heater and mixing machine, for road repair work, has been developed by the Road Repair Equipment Co., 165 Broadway, New York City, of the type here illustrated. It is of sufficient size to repair in one operation a hole 3 cu. ft. in size. It is small enough to be handled by one man.

The heater is similar to a wheelbarrow, having a special body containing a secondary solid body or tray, with a predetermined space allowed between the tray and the special body. In this space there is mounted a gasoline burner, from which a hot flame spreads over the bottom of the tray, producing a uniform heat

A NEW ROAD REPAIR HEATER.

throughout the area of the tray. This gasoline burner is fed from a tank mounted on the handles of the heater immediately in front of the body, permitting free use of the handles, and coincidentally protecting the tank from any damage. Attached to the tank is a hand force pump for application of air to the gasoline for proper mixture.

By a needle valve the proper flow of gasoline to the burner may be controlled by the operator to any desired heat. By this means if the operator desires to put the heater out of service for a time, he can lower the flame and save gasoline. The heater may be put back into instant service by simply turning the needle valve.

By the use of this improved heater a large supply of stone and bituminous materials may be placed along the road at different intervals, and the patrolman, inspector or workman starts out in the morning with the heater, loading his heater with stone, bituminous material and tar, and, upon reaching the first hole, lights the heater, heating the mixture, turning it over with a shovel until the proper mixture and heat is reached, then dumps the mixture into the hole, levels and tamps it into proper place. The complete operation of loading the heater, heating the materials, mixing, dumping and tamping requires less than five minutes.

It is claimed this machine can be used in extreme cold weather, as the heating is always uniform. If used immediately when a portion of road starts to break or disintegrate, it would keep the road constantly in good condition and save sending large gangs to make extensive repairs later on.

It is claimed that this road repair heater is well adapted for the less populated districts, where the patrolman is situated a long distance from the central plant.

OPERATION OF A COUNTY MAINTENANCE ORGANIZATION ON GRAVEL ROADS

By Sam Steigerwalt, County Engineer, Nevada, Iowa.

The selection of the ideal maintenance equipment and the plan of operating it is still a problem with most all of us. This fact is very well illustrated by the 99 different methods used in Iowa to maintain our roads. Equipment and methods used in one county will have no friends whatever in an adjoining county having practically the same kind of road surface and road conditions to work with.

In Story County we have tried out several different kinds of equipment and are now trying out others, with the expectation of changing if somebody finds something better than we have at present.

Our Primary System is composed of one road straight across the central part of the county east and west, and one near each side of the county running north and

south, totaling 64 miles, divided into two patrol districts or patrol headquarters. Two men located at Ames with one Quad truck, one Ford truck, one Cletrac tractor, one 8-ft. Adams grader, with a 12-ft. blade, two 12-ft. drags, and several smaller drags, take care of 24 miles. They do all of the dragging on the 9½ miles between Ames and the Polk County line, and all necessary patrol work other than dragging on the other 14½ miles. We aim to keep teamdraggers on about one-half of the primary road, as these can be hired by the mile and work only when dragging is necessary, while if we kept patrol men enough to do all of the dragging within 24 hours there would not be work enough to keep them busy between draggings, and the total investment in equipment would be more than doubled.

At Nevada we have four men, a foreman, a mechanic, a grader man and a truck driver. They are all truck drivers when necessary and do their special work when that kind of work comes up. Equipment at Nevada consists of one Nash Quad, two F. W. D.'s, one Packard, one Ford, one 12-ft. Adams Reclamation ditcher, one 20:35 Twin City tractor, three 12-ft. drags and several 10-ft. drags.

Twenty-three miles are kept dragged by the Nevada squad, and patrol work other than dragging is done on the balance of the district. This squad also does most of the small repairs on wood bridges over the county, builds inlets and hauls tile and fills tile ditches on the County Road System, besides doing most of the repairs on all of the county trucks, tractors, blade graders, drags, etc.

All of the large trucks are equipped with cabs or storm aprons, and as soon as it starts to rain, at least three trucks are sent out to drag the center of the road to keep the ruts and pot holes from forming an holding water to soak up the roadbed.

For this kind of dragging we are using one Engle 10-ft. drag behind each truck. These drags are long enough to cover the center of the road in good shape and will let the traffic by on one side and do not extend out so far on the other side as to hook into the loose heavy gravel and earth on the shoulder. The trucks travel along about 4 or 5 miles per hour on intermediate speed and do a real job of keeping the roads in shape during a continued rainy spell, when no other equipment could be out in the weather.

As soon as the rain stops two trucks are started out together with two 12-ft. drags or a blade grader and one 12-ft. drag. They cover practically the whole road and keep far enough apart to let the traffic work around one on the right and around the other on the left.

The drags are adjusted so as to drag either in or out, as the road requires. These two trucks will go out from 12 to 14 miles and back in a day, and on the return trip the road, which is now getting almost dry, gets a double dragging.

The next day, if the weather continues cloudy, and the road stays damp, one truck makes another trip with a 12-ft. drag and smooths up the soft places.

During dry weather, just enough dragging is done to keep the traffic spread out over the road surface and prevent ruts from forming. Taking the entire season through, about one-third of the patrolmen's time is taken up dragging.

Our primary roads are all well drained, approximately 500,000 ft. having been placed on the 64 miles.

At present 43 miles have been graveled, and during 1922 14 miles will be given the first coat and 9 miles a maintenance coat.

The patrolmen have hauled about 400,000 ft. of the tile placed; they have filled all of the tile ditch, have spread and worked practically all of the gravel placed, and two men, with the 20:35 Twin City tractor and a 12-ft. Adams grader, working about two days a week during the summer months, have kept the earth roads shouldered up and flat on top, just ahead of our graveling operations.

Gang maintenance on primary road consists of hauling maintenance gravel, which is all done by contract, and tractor grading, which is also done on contract by the hour. In the spring of 1921 the county purchased a 12-ft. Adams Road King with back-sloper, and contracted with H. R. Hilleman, of Marshalltown, to furnish a new 40:60 Twin City tractor and two men to run the outfit at $6.50 per hour for actual time put in. This work consisted of following up the completed drainage and widening the crown out to 28 ft. and building up square shoulders and a flat top preparatory to graveling. Later in the season we widened out 9½ miles of graveled road and scarified the surface and built up the shoulders preparatory to placing a maintenance coat of gravel. This season we have 16 miles of good gravel road that has too much crown, and we are going to widen out and build up the shoulders without scarifying, as we do not expect to place any maintenance gravel on this section this season.

During 1921 this outfit covered 37 miles at a cost of about $200 per mile.

All of the team dragmen are supplied with 10-ft. Engle drags and are paid 40 cts. per mile traveled.

The patrolmen are paid 40 to 50 cts. per hour for actual time worked and will average about $1,000 per year per man.

During 1921 Story County paid out for maintenance on Primary Roads the following amounts:

For patrol maintenance.....	$16,232.14
For gang maintenance.....	30,482.02
For equipment and tools.....	5,954.68
Making a total of.....	$52,668.84
Making an average per mile of..	$ 819.74

The above amount includes tractor grading on 26 miles, maintenance gravel on 26 miles, and a great deal of clearing and grubbing, excavating for inlets, smoothing up tile ditch filling, shouldering up for graveling, and other work which really was construction work in that when once done it is done for a long time.

The 131 miles of county road are divided into 7 districts of 14 to 22 miles each, with one patrolman with team in each district. He is equipped with a small blade grader, slip, plow and dump boards for his wagon, and receives 60 cts. per hour for actual time put in.

These team patrols do very little dragging, as practically the entire county system is covered by farmer dragmen, with teams or small tractors.

They haul gravel for patching short stretches of road, keep the loose gravel worked in, and the grass and weeds scraped from the outside edge of the shoulder, keep the culverts and tile inlets clear of rubbish, and other odd jobs found necessary.

The county maintains two large tractor and grader outfits for shaping up the shoulders of the County Road System. This work cost approximately $200 per mile during 1921.

The total cost of maintenance on the County Road System during 1921 was $34,388.16, or approximately $262.50 per mile, of which $147.43 per mile was for patrol maintenance and the balance for gang maintenance.

We are at present trying out a home-made steel drag, also a large size Iowa Maintainer, and I believe that both of them are going to show results as to efficiency and economy of operation.

The foregoing paper by Mr. Steigerwalt was presented at the recent annual conference of Iowa road officials.

MINNESOTA'S SUCCESSFUL NEW HIGHWAY DEVELOPMENT PLAN

With motor vehicles turning in the bulk of the new money Minnesota broke the previous road building records of the State in 1921, under a plan devised by Charles M. Babcock, State Highway Commissioner. The State used more than $28,000,000 for 1921 highway improvement and maintenance, compared with about $16,500,000 in the previous banner road building year.

Increases in taxes on motor vehicles for highway improvement and upkeep, friends of the plan contend, are more than offset by savings on repairs, tires, gasoline and other car and truck operation costs.

The Babcock plan of highway development is attracting nation-wide attention, partially because of results during the first six months of operation. Graded and gravel-surfaced mileages on Minnesota's primary system of highways have been increased 40 per cent. plus and the paved mileage has been almost doubled, over improvements listed when it was transferred to the State. Relieved of the expensive burden of arterial highway construction and upkeep, counties and towns have more funds available for use on the secondary system or feeder roads.

Babcock Presents Plan

The Babcock plan was brought out by rapidly increasing motor vehicle traffic, which demanded modern roads as it wore out the old turnpikes. Counties and towns were spending every dollar available to keep main roads passable under the growing grind of heavy, high-powered cars, and secondary roads were more or less neglected. The necessity of providing adequate roads was generally recognized; nevertheless, increases in road tax levies were opposed.

Commissioner Babcock presented his plan.

"Let wheels using the highways pay a fair share of road improvement and upkeep expense," he proposed. "Put a heavier tax—the average was $10.60 a year, including the license fee of $5 for three years—on each automobile and truck, and use the proceeds to build up and maintain the trunk highways. Good roads will enable car owners to save more than the tax on repairs, tires, gasoline—"

The automobile owners favored the

idea. Engineers' tests had demonstrated big savings possible in the operation of motor vehicles on good roads over poor roads. Motorists wanted good roads.

"Use the motor vehicle tax revenue and federal highway aid on the trunk roads," Commissioner Babcock continued. "Leave the counties and towns all local tax funds and state highway aid for the secondary or feeder roads. Without the expense imposed by the main highways, they will be able adequately to improve and maintain the feeders. It is primarily a farm-to-market roads plan."

Farmers, too, favored the plan as it was understood. Business and professional men and other citizens fell into the line. Good roads represented an urgent need.

Public demands for better highways became more and more pressing. Funds were insufficient to meet them. Under the state constitution highways were improved and maintained solely by counties and towns; the state was without authority to spend a single dollar, were it available, on actual highway work.

Roads in Minnesota, as in other states, were years behind traffic demands, and going steadily backward. The county system on arterial routes brought patch-work development to emphasize the need of state control of interstate and intrastate arteries.

Commissioner Babcock sought so to provide in his plan.

Amendment No. 1 on Ballot

The Minnesota Legislature of 1919 submitted to popular vote, at the following general election, Good Roads Amendment No. 1, proposing to effect the Babcock Plan.

First, the amendment proposal was to create and establish a system of trunk highways, to be constructed, improved and maintained forever by the state. Specified routes approximated 7,000 miles and connected county seats and important towns of every section, and also the famous ten thousand lakes and other recreational regions. Additions would be permitted upon completion of 75 per cent. of the mileage.

Secondly, the state trunk highway fund was created to finance trunk system operations. It included federal aid allotments and the proceeds of a more onerous tax on motor vehicles using the highways, in lieu of personal property and other levies except city wheelage taxes. A further provision was for the authorization of trunk highway bond issues to run not to exceed 20 years and to limit to $75,000,000 the amount that might be lawfully outstanding at any one time.

Borrowed funds are being used on the trunk system, although the state has issued no highway bonds. To insure against cessation of work by counties on the trunk routes in anticipation of adoption of Amendment No. 1, the Legislature of 1919 also authorized counties, under certain restrictions, to issue up to $250,000 each of bonds, proceeds to be expended on the trunk highways, and virtually pledged reimbursement by the state. Many counties acted under the law.

Adopted by Huge Majority

Good Roads Amendment No. 1, carrying adoption of the Babcock Plan, was passed Nov. 2, 1920, by a vote of 526,936 to 199,603. The big majority was attributed in part to an educational campaign in which the newspapers of the state took an important part, and which was directed by the Minnesota Highway Improvement Association.

Legislature Provides Machinery

The Babcock Plan was made effective by acts of the Legislature of 1921. The State Legislature made a far-reaching investigation to determine the relative merits of the single commissioner or board system, with the result that the single commissioner plan was continued.

Motor vehicle tax schedules were given extensive study by legislative committees. Rates finally adopted were based upon factory list prices, with depreciation allowances of 25 per cent. for 3 and 4-year-old machines, and 50 per cent. on cars 5 years old or older.

The passenger car rate is 2 per cent., with a $12 minimum, and the truck rate 2¼ per cent., $15 minimum. The average was estimated at less than $20 a year. Dealers are assessed $25 a year for licenses and charged nominal fees for extra license plates for cars which can be used lawfully only for actual demonstration purposes. Dealers in used cars must pay regular rates on cars remaining in their possession after Nov. 1. Taxes for the last six months each year are at half rates. Penalties attach for delayed payments. Motor vehicle taxes are collected and license plates issued by the secretary of state.

General highway statutes were completely recodified to correlate new sec-

tions with those affecting the local highway authorities. The measures were passed with big margins in both branches of the legislature.

Highway Program Speeded

Governor J. A. O. Preus signed the bills April 25, 1921, and announced the reappointment of Commissioner Babcock under the new laws, effective immediately.

The commissioner and his aides started at the zero mark. Lack of funds and authority precluded any preliminary work in advance of enactment of the highway bills. The construction season was well opened and policies and projects remained to be decided.

Commissioner Babcock named Mr. Mullen chief deputy and highway engineer. Experienced men already identified with the department were retained, and the list included J. T. Ellison, bridge engineer; W. F. Rosenwald, maintenance engineer; O. L. Kipp, construction engineer, and F. C. Lang, engineer in charge of tests and laboratories.

From the small nucleus a greatly enlarged administrative force was built up. County road engineers, familiar with local conditions in various sections, were added to the staff, filling the positions of eight division engineers and sixteen district maintenance superintendents. Offices of the highway department spread to spaces on six floors of a St. Paul building; then a capitalist friend offered to erect the department a home, which is nearing completion now.

All energies in the department were centered in one direction: to start field operations on the earliest possible date—"to make the dirt fly."

Effective Maintenance First

"The first move must be toward putting and keeping every part of the 7,000-mile trunk system in good, passable condition," Commissioner Babcock ordered. Immediate steps followed to put into the field a maintenance force organized along lines worked out several years previously by Engineers Cooley and Mullen. The latter had outlined the plan at a convention of highway engineers and it had been partially effected in a neighboring state with successful results.

The purpose was to extend early benefits to every locality of the state by providing a constant-duty patrolman or roadmender for each 5-mile section of the trunk highway system. Every patrolman must live in or near his "beat" and furnish his own team or tractor, grader, drags and other tools. The going wage is paid the patrolman and they receive an allowance for rental of equipment, the latter method being adopted to insure better care of tools.

More than 1,200 patrolmen were covering about 6,200 miles out of the 7,000-mile system within 60 days, according to official records. In some cases the patrolmen worked to disadvantage at the start because of poor foundations, and state fleets of heavy outfits were ready to help them.

War Equipment in Service

Fleets were made up of 50 tractors and 150 trucks—part of the surplus war equipment turned over by the Federal Bureau of Public Roads. The trucks were overhauled and fitted with hoist bodies for handling gravel, and the trucks converted to constructive work, in big machine shops maintained by the highway department on the state fair grounds.

Extensive use of heavy machinery made a sharp demarkation between the old and new methods on trunk highways. The combined equipment was found equal to dressing up roads at the rate of 5 miles a day. The tractors drawing heavy blades would shape up and make a good wheel track and the trucks follow on to add a surfacing of gravel.

The maintenance system soon began showing results, a spirit of friendly rivalry having been created among patrolmen to elicit their best efforts. The public ordinarily judges a road by its riding qualities, the highway officials explained, and a new standard of smoothness over the system was being generally commented upon and winning more friends for the new good roads movement.

New Construction Launched

New construction projects were undertaken with the maintenance plans well started.

"Improvement of poor sections in long mileages of otherwise good roads—strengthening of weak links in the chain—will be the initial aim," Commissioner Babcock announced.

With Mr. Mullen, possessing first-hand knowledge of conditions and needs through long experience in the department, the commissioner toured more important trunk routes by automobile, averaging 200 miles a day.

New construction projects were listed by the executives in the field. Orders were wired to St. Paul headquarters.

Survey parties were rushed out in all directions to procure necessary engineering data. When undertakings were ready and estimated at $1,000,000, the group was advertised for bids and wide competition was obtained.

The low bids were most reasonable, engineers announced at the time. Paving was contracted as low as $28,300 a mile, while other states were reported fighting for proposals under $30,000 a mile without success. Correspondingly low figures were secured on grading and gravel-surfacing, ranging from 40 to 50 per cent. under those paid by counties the year before, and almost back to pre-war levels, it was stated.

Operations in Full Swing

As in the maintenance department, so also in the construction department, progress charts on July 15 showed contract jobs under way on a large scale. Nearly 75 projects, running well above $5,000,000, were going forward in almost as many widely distributed sections of the state.

One big handicap was forced curtailment of the program for the first regular season. The State Legislature had authorized no issues of trunk highway bonds and federal highway aid was not forthcoming as anticipated.

Reimbursement bonds, previously referred to, had been voted, however, by a number of counties, and large balances were available to help the department enlarge the first season's operations.

County officials concluded, however, that in any event the state would keep up and gravel the trunk routes, and insisted as a rule that bond money be used for hard-surfacing. This resulted in an abnormal amount of paving during 1921.

Approximately $7,500,000 of reimbursement bond money was used and some counties gained precedence in local improvements on the system.

Funds Exceed $28,000,000

Under the new scheme Minnesota was using more than $28,000,000 a year for road building and upkeep, against about $16,500,000 maximum under the old plan.

Motor vehicle tax revenues were running up to the $6,000,000 total expected, and with the reimbursement bond money, the trunk funds aggregated $13,500,000. Federal aid later added $2,123,000 to the trunk fund. Counties and towns were furnished more than $12,500,000 for exclusive use on the secondary highway system—about $11,000,000 of local tax revenues and $1,650,000 of state aid.

The first season of operation under the Babcock plan, with unusually favorable construction conditions, insured a banner year for general highway development in Minnesota.

When the trunk highway system was transferred to the state it was listed with 1,499 miles graded, 1,371 miles graveled and 112 miles paved, the balance being in lesser degrees of advancement and mainly of good dirt roads. Adding 103 miles of hard-surfacing, the state department nearly doubled the paved mileage, while the graded mileage was extended by 680 miles and the gravel-surfaced mileage by 438 miles, all within 6 months. Also, maintenance forces reshaped 713 miles and regraveled 462 miles.

The expenditures approximated $4,758,026 for grading, $1,605,122 for graveling, $3,549,259 for paving and $514,047 for bridges, and with the $3,000,000 set aside for maintenance, made the regular season total of $13,426,454 on trunk routes and exclusive of betterments on the secondary road system.

Reaches for More Work

The construction season well advanced, highway aid legislation still dragged in Congress. Commissioner Babcock saw a serious unemployment situation looming, and a possibility of big relief through carrying highway operations through the winter months.

The "more work—better roads" movement was started in Minnesota and an effort made to enlist the co-operation of other states. Herbert Hoover, Secretary of Commerce, already was urging action in that direction, and the Minnesota Highway Department was calling the possibilities to the attention of local road authorities throughout the state. Much road work could be done even more economically and advantageously in winter, it was pointed out.

Commissioner Babcock was appointed a member of President Harding's conference on unemployment. He went to Washington with concrete figures on possibilities offered by winter work on Minnesota highways. The proposal was the basis of an outstanding recommendation by the conference.

Minnesota officials, commercial, civic, labor, farm and other organizations and public-spirited citizens assisted by petitioning officials at Washington to speed action on the highway legislation and

newspapers again helped gain practical results.

The federal highway aid was assured and Commissioner Babcock resigned as regional director for President Harding's conference to speed the state program of winter work on highways.

$4,500,000 of Winter Work

A ruling was given by Clifford L. Hilton, Minnesota Attorney General, that the collection of motor vehicle taxes might lawfully be anticipated to match federal aid. Commissioner Babcock's tentative plan is to use about $4,500,000 on winter work, to hasten needed road improvements and prevent forced idleness among workingmen and avert suffering among their dependents.

Bids early in December on 44 widely distributed projects, estimated at $2,293,500 and covering more than 300 miles, were called for within 10 days after Congress voted federal aid. Deputy Mullen continued conferences with construction and division engineers to add more jobs to the lists without unnecessary delay.

Heavy excavating with steam shovels, distribution of gravel and other materials predominates, the work proposed to furnish jobs for hundreds of men.

Save for actual permanent construction, highway funds are being conserved for heavy-traffic season benefits, highway officials explain. Accordingly, snow removal and other winter work is being limited.

Bigger Benefits Indicated

Formal opening of the first 100 miles of continuous pavement on the Minnesota trunk highway system was celebrated Nov. 15, 1921, at St. Cloud, the northern terminus of the paved way. Speakers took occasion to compliment the highway department on first year achievements under the Babcock Plan, and plans were reported that the longest continuous pavement another year will be nearly doubled in length.

Minnesota people take pride in the Babcock Plan. Automobile owners are unstinted in their praise of improved road conditions in virtually all sections of the state. Farmers begin to see fulfillment of the "farm-to-market road" forecast. Tourists in increasing thousands roll in from other states to the numerous recreational regions and join in lauding Minnesota's good roads.

The importance of adequate highways and the benefits sure to follow them are appreciated in Minnesota.

MOTOR TOURIST CAMPS

"What goes to make an ideal camping ground?" This question has been answered by L. P. Strothman, engineer and map designer and head of the United States Touring Information Bureau, Waterloo, Ia. After a survey of the camping grounds in all sections of the United States, Mr. Strothman has issued the following specifications for the guidance of city and town officials:

"Camping grounds should be easily accessible from the business section. Signs should be placed about the business section and on roads leading into town to direct tourists to the grounds.

"Signs in the grounds should direct tourists to a reliable source of touring information and other signs should give rules and regulations plainly.

"Wooded ground is preferable and much more pleasant. Natural drainage is essential, and when possible the camping grounds should be on high rather than low ground in order to afford protection from insect pests.

"Permanent shelter would be appreciated by every tourist in event of inclement weather, and will add much to the value of the grounds as an advertising asset for the city. Such shelter should have a smooth floor surface. Stoves should be set up and maintained in usable condition.

"Sanitary toilets, with due respect to decency, should be provided.

"Garbage cans are essential and signs should be posted commanding that refuse be deposited in designated places.

"Fresh water should be piped from the city supply. If this is impossible, then deep well water should be available.

"Fuel should be attainable. In many cities wood is cut and corded in the grounds by order of park officials.

"A few lights about the grounds and in the shelter will be appreciated by tourists. Whenever possible, telephone facilities should be available.

"Some form of protection is always desirable. If a caretaker cannot be afforded, then direct communication with the police station should be established.

"Access to bathing beaches, fishing waters and other amusements will be enjoyed by tourists.

"A good camping ground is a valuable asset to any town or city, and any money expended in making it of real service to tourists will not be wasted."

CREDIT FOR AUTHORSHIP

Due to an oversight in the mechanical preparation of the May issue of this magazine, credit was not given to Mr. John F. Druar, of the firm of Druar & Milinowski, Consulting Engineers, Globe Bldg., St. Paul, Minn., for the authorship of the article beginning on page 29 and entitled: Facts and Figures Indicate That Now is the Time to Install Public Improvements. As the article was written for the exclusive use of this magazine the editor naturally regrets that the usual credit lines on authorship were omitted in the make-up of this very interesting and timely article.

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Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—Alabama Construction Co., Montgomery, awarded contracts as follows: Monroe Co., 8.23 mi. gravel road betw. Jones Mill and Monroeville, at $34,405; Fennell Co., Tuscaloosa, Ala., awarded contr. for 10.29 mi. penetration macadam, balance gravel; total 13.5 miles; $223,814.

Cal., Maricopa—Federal Constr. Co., Call Bldg., San Francisco, awarded contract for paving California, Main, Center, Kern, Hazeltine, Klipstein and Poso Sts., at $115,800.

Cal., Sacramento—Richmond-Page & Co., San Francisco, awarded contract for grading state highway, Lake Co., bet. West boundary and Upper Lake (about 9 miles) at $167,359; W. A. Dontanville, Hollister, contract for paving state highway in San Benito Co., bet. San Juan and Pajaro River (4.6 miles cem. conc.), at $47,802.

Cal., Sacramento—Grant-Smith & Co., 708 Balboa Bldg., San Francisco, awarded contract for paving with bitum. macadam 11.73 mi. state hwy., Sonoma Co., at $169,366.

Cal., San Francisco—W. A. Kettlewell & Sons, Oakland, awarded contract for impvt. of so-called Cuesta Grade betw. San Luis Obispo and Santa Margarita—about 3.5 miles, at $78,205. State will furnish materials at $99,920.

Del., Dover—D. E. O'Connell & Son, Ridley Park, Pa., awarded contr. for Contr. CN-6, 5.137 mi. Glasgow-Bear Sta., at $148,815; Wm. P. Staats, Phila., Pa., awarded contract for Contr. CS-15, .71 miles thru Hillsboro, Sussex Co., at $22,237; Benjamin Franklin, Jr., Philadelphia, contract for Contr. CS-17, 3.33 miles, Cokesbury-Church-Cloverdale Cross Rds., at $104,227; Jas. A. Hirons, Dover, contr. for Contr. No. 45, 1.65 mi. Camden-Cooper's Co., Kent. Co., at $61,213.

Fla., Jacksonville—Thos. Bryan, Fort Lauderdale, awarded contract for road work in Palm Beach Co., section of Okeechobee cross-state rd. from bend in West Palm Beach canal to Belle Glade on Hillsboro canal (20 miles), at $190,000.

Fla., St. Petersburg—Georgia Engr. Co., Augusta, Ga., awarded contract to pave 43,840 ft. with vitr. brick, at $306,652.

Fla., W. Palm Beach—Tom. Bryan, Ft. Lauderdale, Fla., awarded contract to improve road; install culverts and surf. 20-mi. Okeechobee Rd., from Mile Post No. 21 to Belle Glade on Hillsboro Canal at $190,000. Conglomerate material of marl, rock and shell, 24 ft. wide.

Idaho, Coeur, d'Alene—Fiorito Bros., Seattle, awarded contr. for paving Apple Way from city limits to Idaho-Washington line, at $295,818.

Ill., Danville—Vermilion County let contract for paving 15-D Rd., Sects. T, U, V, W, X and Y to Osborn, Allen & Hegg, Covington, Ind., at $53,471; Bishop & Curdle, Danvile, at $145,981; H. H. Lewis & Co., Hoopeston, at $97,462.

Ill., Waukegan—Following contracts let: Rockland Rd., to Eclipse Constr. Co., Lake Villa, Antioch Rd., to Geo. Wade; Lake Zurich-Wauconda Rd., to Fred Nelson. Addresses of contractors and amt. of their bids are as follows: Nelson, 1244 Marquette St., Racine, $120,525; Wade, Kenosha, $79,031; Eclipse Constr. Co., Winnetka, Ill., $78,052.

Ind., Indianapolis—Chicago Heights Coal Co., awarded contract by State Hwy. Comn., Indianapolis, for concreting Dunes Hwy.—Mich. City to Baileytown—10.7 miles, at $206,145.

Ind., Ft. Wayne—Moellering Constr. Co., awarded contract for con. of Lima Rd., at $362,374.

Kans., Topeka—List & Hallock, Kansas City, Mo., awarded contract for paving 10.2 miles Topeka Ave., road from city limits to Osage Co. line, at $314,059. Work includes grading and culverts. Surface will be of concrete.

Md., Hagerstown—Thomas, Bennett & Hunter,

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TRADE MARK

awarded contract to construct 11 miles conc. shoulders on Frederick Rd. bet. Ridgeville and Lisbon, at $101,660.

Mass., W. Springfield—Adams & Ruxton Constr. Co., 33 Lyman St., Springfield, awarded contract for paving, grading and finishing west approach to new Conn. River brdg., at $106,389.

Mich., Benton Harbor—St. Joseph Constr. Co., awarded contract to build the Meadowbrook hwy. in Bainbridge, Benton and Pipestone Twps., at $63,696, also contr. for Hillendale Rd. so., 6½ mi., at $94,000, Sodus Twp. Snyder Bros. awarded contract for impvt. of Hillendale Rd. north, Benton Twp., at $55,000. All the roads will be built of macadam and be 12 ft. wide.

Mich., Detroit—Rockford Constr. Co., Rockford, Ohio, awarded contract for bldg. 1.1 mi. rd. in Dundee Twp. 18 ft. wide with 8 ins. conc., at $16,179; state to furnish cement; Hilding & Rabe, Grand Rapids, awarded contract for constr. of 7.3 mi. Ida-Bedford Rd. 18 ft. wide, 4-in. macadam base and 8 ins. conc. at $181,000; W. H. Knapp, Monroe, awarded contr. for constr. of 8 7-16 miles of north end of Flat Rock pike, 20 ft. wide, 9 ins. conc., re-enforced bars every 6 ft., at $206,000.

Mich., Mt. Clemens—Newberry & Weed awarded contract for 3 mi. slag base and gravel top rd. in Armanda Twp., at $18,532; 6 mi. of pavement in Warren Twp.; to Jas. A. McKay & Son, Detroit, at $148,176.

Minn., St. Paul—Thornton Bros. Co., St. Paul, awarded contract for 2 miles brick paving on Concord St., South St. Paul, at $120,000.

Mo., Independence—J. P. Kealy, awarded contract to pave rock asph. 5 miles of road from Hickman Mills to Longview Farm, at $171,000.

Mo., Monticello—C. P. Reilly & Co., St Louis, Mo., awarded contract for 8.37 miles State Rd. from Canton southward and westward; also 8.94 miles State Rd. northward and southward thru LaGrange Special Rd. Dist., at $221,000.

Mont., Glendive—McGuire & Blakesley, Bozeman, awarded contr. for conc. paving at $88,000.

N. Y., Binghamton—Municipal Constr. Co., U. C. N. B. Bldg., Utica, awarded contract for paving Vestal Ave. (bitulithic) at $74,478.

N. Y., Franklinville—Morgan & Bock, Olean, awarded contract for paving Pine, Chestnut and Maple Sts., at $73,497.

N. Y., Fredonia—Oatka Engr. Co., Warsaw, awarded contract for section improved hwy. betw. Chautauqua and Mayville, 3.75 miles, at $112,874.

N. Y., Fulton—Louie Constr. Co., Meriden, Conn., awarded contract for impvt. of streets here at $176,912.

N. Y., Hornell—Kennedy Constr. Co., Hornell, awarded contr. for paving Cottage Ave., Allen, Elm, Grand, Washington and N. Church Sts.; 11,000 yds. brick, at $63,259; Hornell St., Chaddock Ave. and Adsit Pl. macadam, $15,308 to L. Dennison, 162 N. Main St., Bemis Ave., and Adsit Pl. conc., $6,505, curbing and guttering Park, Oak, Davenport and Albion Sts., at $6,221.

N. Y., Lockport—Bd. of Supvrs. Niagara Co., let contr. for paving 12.25 mi. Lake Rd., conc., to G. A. Hitchcock, Clymer, at $290,584; 2.02 mi. Military Rd., in Niagara, conc., to F. J. Mumm Contg. Co, 176 Best St., Buffalo, at $48,547; 3.33 mi. Beach Ridge Rd., bitum. macadam, to Siller & Waite, Norwich, $55,839; 2.07 mi. Stone Rd., Hartland Twp., and 1.39 mi. Griswold St.; (Gilbert Corners) macadam, to F. H. Rhody, Albion, at $30,470 and $23,136, respectively.

N. Y., Niagara Falls—Board of Supervisors awarded following contracts: Military Rd., 2.02 mi., concrete, to F. J. Mumm Contracting Co., at $48,546; 12.231 mi. conc. on Lane Rd. to Geo. A. Hitchcock, at $290,584; Beach Ridge Rd. in town of Pendleton, 3.33 mi. to Siller & Waite, at $55,839; F. H. Rhody, Stone Rd. in Hartland, 2.07 miles at $30,470; Gilbert's Corners-Griswold Street rd., in Royalton; 1.39 mi. to F. H. Rhody, at $23,136; Mountain Ridge Rd., Sec. 2, in Lockport, .533 mi. to Louis H. Gripp, at $14,588; Cambria-Lockport Town Line Rd. in Cambria and Lockport, .3896 mi. to Roberts & Weahl, at $10,638.

N. Y., Rochester—P. H. Murray, Rochester, awarded contract for reconstructing Part 1 B of Kanona-Prattsburg Rd., 3.29 mi. at $79.124.

N. Y., Syracuse—Following contracts let: J. H. Gallup, awarded contr. for constr. of bitum. Topeka pavement with conc. curb in Spencer St., at $40,692; Brattle Rd., asph. and stone curb, to Guy B. Dickison, at $14,252; East Laurel, bitum. Topeka with conc. curb, to C. T. Hookway, at $10,009; Farmer St. asph. pavement with stone curb, to G. B. Dickison, at $9,145; Townsend Pl. bitum. Topeka with conc. curb, W. Gallup, at $4,390; Oak St. asph. with stone curb, F. J. Baker, at $20,661; Pattison St. asph. with stone curb, F. J. Baker, $10,650; W. Fayette, Nelson, to Wilbur, bitum. Topeka with conc. curb to F. J. Baker, $7,467; Vine St., Robinson to Pattison, F. J. Baker, at $6,029; Sedgewick Dr., asph. with stone curb, to G. B. Dickison, at $19,412.

N. C., Bessemer—Davis-Wilcox Constr. Co., awarded contract to pave several streets; 27,700 sq. yds. plain conc., rein. conc. or sheet asphalt, etc., at $85,000.

N. Y., Utica—Municipal Constr Co., City, awarded contract for paving Vestal Ave., at $59,005.

N. C., Jefferson—Turner-Martsoe Constr. Co., Warrensville, N. C., awarded contract in conjunction with McNeill-Allman Constr. Co., Jefferson, to grade and gravel surface 20 miles of roads and bridgs., at $140,000.

Ohio, Bucyrus—F. L. Battdorf, Kansas, Ohio, awarded contract for 6 mi. brick paved country roads in Chatfield and Sandusky Twps., Crawford Co., at $229,677.

Ohio, Columbus—Franklin Asphalt Paving Co., awarded contract for paving Neil Ave. at $111,420 and Cleveland Trinidad Paving Co., contr. for paving Third St., at $104,332.

Ohio, Columbus—Director of Hwys. Herrick awarded following road contracts: Crawford Co. job to Scott Constr. Co., Lima, at $232,802, brick constr.; Allen Co. 3 mi. Lima-Sandusky Rd., brk. to E. L. Reed, Defiance; Putnam Co. 1 mile Lima-Ottawa Rd., Kentucky rock asph. to Scott Constr. Co., Lima; half a mile Lima-Ottawa Rd. brk. to same contractors; Union Co. 4 mi. Marysville-Kenton Rd. macadam, to L. G. Rockholt, W. Mansfield; Clermont Co. 1.5 mi. Cincinnati-Chillicothe Rd., asph. to Hogan & Garrison, Milford; Lake Co. 1 mi. Painesville-Warren Rd., conc. to L. G. Booth, Painesville; Mercer Co., 2.5 mi. Celina-Greenville Rd., conc. to Lynn Constr. Co., Pauldings; Wyandotte Co. half a mile Upper Sandusky-Marion Rd. 1 mile Upper Sandusky-Findlay Rd. and mile of Fostoria-Carey Rd., all brick, awarded to Newark Paving and Constr. Co., Newark.

Ohio, Marysville—Wm. C. Moore, Marysville, awarded contract for rebuilding Lancaster and Newark Rd., Fairfield Co., at $70,000.

Ohio, Washington—O. Junk, awarded contract for 6.24 miles rein. conc. roadway here at $190,000. Road extends so. from Ross Co. on Jackson pike and is 16 ft. wide.

Pa., Harrisburg—State Hwy. Dept. let following contracts: Clearfield Co., Coalport Boro., 4,085 ft. to Thos. J. Strickler, Huntingdon, $37,816; Bradford Twp., 16,074 ft. to Johnson & Kearns, Dubois, $118,848.

Pa., Harrisburg—Donald McNeil Co., Pittsburgh, awarded contract in Allegheny Co., for impvt. of Pittsburgh-Kittanning Hwy. extending 13,365 ft. from near New Kensington brdg. over Penn. R. R. to south Boro. line of Tarentum, Springdale Boro. at $129,825; Smethport Constr. Co., Union City, awarded contr. for Armstrong Co. improvement of 19,224 ft. on Kittaning-Franklin Rd. E. Franklin Twp. from Glade Run to intersect. of Route 71, at approximately $140,086.

Pa., Harrisburg—R. D. Richardson Constr. Co., Scranton, awarded contract by St. Hwy. Dept. for 789 ft. Hunlock Twp. Luzerne Co., at $19,892; 15,334 ft. Rimersburg Boro., Toby & Madison Twps., Clarion Co., to R. V. Baldwin, Coraopolis, at $121,291; 6,186 ft. Woodward Twp., Clearfield Co., to R. J. Delong, Williasmport, at $53,083; also 4,092 ft. Houtzdale Boro., Clearfield Co., at $38,601.

S. C., Florence—Southern Paving Constr. Co., Chattanooga, Tenn., awarded contract for constr. of 21 miles asph. street paving here, at approximately $1,000,000.

Tenn., Mt. Pleasant—Smith, Pitts & Co., local, awarded contr. for constr. of road from Lawrenceburg to Waynesboro, dist. of 15 miles, at $103,000.

Tenn., Nashville—Following contracts let by St. Hwy. Dept.: F. A. P. 63-B, Cherokee Co., grade 8.05 mi. State Hwy. 17 from Gallatin to Davidson Co. line; hand-placed base with rock asph. surface, to Moore Bros. & Carr, Columbia, Tenn., at $179,694; F. A. P. 65-A, Warren Co., grade 6.67 mi.

State Hwy. No. 1, from McMinnville to Cannon Co. line, stand. hand-placed base course with bitum. macadam penetration surf. to J. T. Calhoun & Co., Nashville, Tenn., at $160,307; FAP No. 4, Bedford Co., betw. Shelbyville and Moore Co. line; surface treatment, to Theo Vogelsberg, Louisville, Ky., at $17,561.

Tex., Waco—Kuykendall & Shelton, Temple, awarded contract for bldg. Waco-Mexia Rd., at $77,955.

Tex., Wichita Falls—Wichita County, awarded contract by State Hwy. Dept., Austin, to construct 8.2 miles Hwy. No. 2, 18-ft. conc. pavement. Proj. 262, at $281,166.

Va., Richmond—Following contracts let by State Hwy. Comm.: 8.25 mi. bet. Pendleton and Louisa, to Allport Constr. Co., Richmond, at $202,165; Scott Co., 5 mi. graded rd. to Snead Constr. Co., at $61,522; Halifax Co., 10 mi. rd. bet. Vernon Hill & Houston to Perkins & Barnes, Blackstone, Va., at $28,840.

Va., Richmond—Kelley & McLain, awarded contract for impvt. of Franklin and 9th Sts.; A. J. Boyle, Baltimore, Md., Grave St. to Wingo and Deaner; terra cotta segment blks. Cost about $100,000.

Wis., Florence—Brogan & McGinley, Crandon, awarded contr. for constr. of Armstrong Creek-Florence Rd. Proj. 206, at $40,612; also contract for constr. of Irma Gilbert Rd. Proj. 223, at $43,644.

Wis., Green Bay—F. P. Coughlin Constr. Co., Chicago, awarded contr. for asph. paving on Shawano Ave., Elmore St., School Pl., at $150,000.

Wis., LaCrosse—State Hwy. Comm. has decided to award contract for Fed. Proj. 136, Viroqua-Prairie du Chien Rd., Vernon Co., to Campbell Constr. Co., Minneapolis, at $78,069; Ross Paulson, Granton, Wis., awarded contract for FAP 214, Black River Falls-Millston Rd., at $60,372; 18-ft. shale surfacing, 11.3 miles in length.

Wash., Olympia—C. E. Davison, Roundup, Mont., awarded contract for impvt. of Pend Oreille Hwy., —Cusick to Locke—7.05 miles, at $47,962; Rich & Markus, Missoula, Mont., awarded contract for impvt. of Inland Empire Hwy., Yakima Co., 6.56 miles—Buena to Dalton, at $167,004; Campbell-Wilson Co., Sunnyside, Wash., awarded contract for impvt. of Inland Empire Hwy., 3.80 miles—Dalton to Granger—at $31,772.

Wash., Walla Walla—Pacific Coast Paving Co., awarded contract for constr. of Donahue Rd., from Prescott to Eureka, at $93,918.

Wis., Waukesha—Wilson-Johnson Constr. Co., Appleton, awarded contract for impvt. of Oconomowoc-Dousman Rd. Hwy. 67, at $86,751; 6 mi. conc. surf. Dousman Rd. to Robt. L. Reisinger Co., 464 Oakland Ave., Milwaukee, at $15,232, 1 mile surface.

SEWERAGE AND SEWAGE TREATMENT

B. C., Kamloops—Kamloops Plumb. & Heat'g Co., awarded contract for constr. of east end sewer at $47,980.

B. C., Vancouver—Nicholas Cosco, 1,367 Seymour St., awarded contract for constr. of approx. 1 mile of sewers in Point Grey, mostly in the Strathcona Dist., at $28,736.

D. C., Washington—Warren G. Brenizer, awarded contract for constr. of Conn. Ave. sewer at $1,780; Broad Branch trunk in Nevada Ave., from Chapel Rd. to Legation St., at $31,004; also Newark St. comb. sys. from Reno Rd. to 33rd Pl., at $2,676; Adam McCandlish, contr. to construct O Street replacement in O St. from 1st to N. J. Ave. at $4,045.

Fla., West Palm Beach—The Hanberry Constr. Co., Miami, awarded contract for Sewer Dist. No. 3 at $30,645; Sewer Dist. No. 4 to L. E. Michler, at $18,692.

Ga., Atlanta—Following contracts for sewer work let by Clark Donaldson, Engr. of Sewers: Wood Rueker Constr. Co., for Orne St. sewer at $126,000; J. B. McCrary Constr. Co., Highland Ave., sewer at 85,000; McDougald Constr. Co., for san. outfall sewer in Los Angeles Ave., at $16,485; Meadow Constr. Co., to extend Whitehall Street trunk sewer from Donally Ave. to Holderness St., at $28,106.

Iowa, Ames—Sorenson Drainage Co., Slayton, Minn., awarded contract for outfall sewers at $9,000; sewage treatment plant to Nelson and Aldrich, Spencer, at $48,742.

Ky., Louisville—Chas. F. Smith, Dayton, Ohio, awarded contract to construct Sec. E. of Middleton branch project in Cherokee Park, at about $25,000.

Mass., Boston—Wm. Barrett Co., awarded contract for sewerage works in Farragut road extension, South Boston, at $23,925; Timothy Coughlin, for sewerage works in Beverly St., Causeway St. abt. 339 ft. northwest, city proper, at $5,688. Jos. T. McCabe, awarded contract for sewerage works in B and 7th Sts., overflow extension, So. Boston, at $27,052.

Mich., Detroit—Hammen & Co., Mankato, Minn., awarded contract for 16,245 ft. 8-in. vit. crock sewer in Dix Ave., for Dix-Ferndale Land Co., at $25,000.

Mont., Deer Lodge—R. M. Barsden & Co., awarded contract for constr. of sewers in Dist. No. 68 on west side, at $16,498.

Mont., Glendive—Jas. Kennedy, Fargo, awarded contract for storm sewers at $58,000.

Neb., Omaha—Following contracts let for sewer work: 1-Dists. 739 & 733, Connolly & Fitch, $2,742; (2) Dist. 651, Gus Carlson, $4,867; both Omaha; (3) Dist. 633, Dunnegan & Briggs, Shenandoah, Ia., $41,405; (4) Dists. 738 and 630, Omaha Sewer Const. Co., Omaha., $20,000.

N. J., Paterson—Arnold More Co., Newark, awarded contract for installing sewer connections here, at $26,000.

N. J., Jersey City—Holbrook, Cabot & Rollins Corp., 52 Vanderbilt Ave., New York, awarded contract by Passaic Valley Sewerage Commrs., for continuation and completion of Sec. 2, outfall pressure tunnel, beneath portion of New York Bay and Jersey City, at $2,124,525.

N. Y., Durham—A. H. Guion & Co., Gastonia, N. C., awarded contract for sewers at $15,000.

N. Y., Long Isl. City—H. J. Mullin Constr. Co., Inc., Jamaica Ave. & 44th St., Jamaica, awarded contract for sewer in Norwood Pl. (166th St.) at $311,855 (Proposal B).

N. Y., New York—Pres. Bronx Boro. let contract for sewer in White Plains Rd., etc., to J. L. Sigretto & Co., Woodhaven, at $47,446; storm water drain in E 233rd St., to Anita Constr. Co., 2975 Marion Ave., $98,892; rebldg. existing conc. culvert across and under Gun Hill Rd., etc., to C. W. McDonald, W. 10th St., Brooklyn, at $9,295.

N. Y., Syracuse—Sam Palmisana, awarded contract for 17th Ward sewer system, at $25,815.

Okla., Waynoka—E. W. Eby, Wellington, Kans., awarded contract for constr. of sewer system here, at $28,749.

S. D., Timber Lake—W. B. Carter, 606 United Bk. Bldg., Sioux City, awarded contr. for construction of sewer system at $25,887.

Tex., Kerrville—McKenzie Constr. Co., San Antonio, awarded contract to construct sewage disp. plant at American Legion Sanitarium, at $37,345.

Wash., Seattle—F. N. Badolato, awarded contract for W. Dawson St. et al. sewers, clay pipe except item 4, which shall be 15-inch conc. pipe and using 45-inch premoulded conc. sewer (item 9), at $137,453.

Wis., Appleton—Wilson Co., awarded contract for contstr. of sewers in First, Fourth and Sixtn Wards, at $16,639.

Wis., Fond du Lac—Geo. W. Mulholland Co., Rockford, awarded contract for constr. of approx. 1.5 miles strm and san. sewers at $13,628.

Wis., Milwaukee—Patrick Garahan, Racine, awarded contract for sewers by Garden Homes Corp., at $13,387.

Wis., Milwaukee—Du Pont Engrg. Co., Wilmington, Del., awarded contract for sedimentation and aeration tanks at Jones Island sewage disposal plant, 95,000 bbls. cement, 154 tons sand and 10,000,000 lbs. reif. steel.

Wis., Spooner—Pastoret Constr. Co., 308 Sellwood Bldg., Duluth, awarded contract for sewerage system, including 25,243 lin. ft. 6-15 in. sewer pipe, 68 manholes, one comb. manhole one inspection pipe, sewage treatment plant, steeling tank, sludge bed and appurts., at $44,000.

WATER SUPPLY AND PURIFICATION.

Cal., Glendale—Peter L. Ferry, 614 E. Acavia, Glendale, awarded contract at $3,600 ft. laying

1,100 ft. 4-in. and 600 ft. 6-in. c. i. pipe in San Fernando Rd., at $2,375 for laying 1,200 ft. Matheson pipe in 10th St and at $15,210 for 5,000 ft. 8-in., 300 ft. 6-in. and 250 ft. 4-in. c. i. pipe in Grand Blvd. and Cerritos Ave.

Cal., San Francisco—Contr. for furnishing and delivering four 20,000 kva. elec. generators and accessory equipt. for Moccasin Creek Power Hetch Hetchy Proj. Contr. 80, to General Electric Co., Rialto Bldg., $260,285; four 25,000 h. p. impulse water wheel units with individual oil pressure sets, Contr. 79-A, to Pelton Water Wheel Co., 19th and Harrison Sts., $248,800; eight 36-in. gate valves with hydraulic operating cylinders, Contr. 79B, to Coffin Valve Co., Monadnock Bldg., $37,580.

Que., Quebec—Following contracts let by Waterworks Comm.: Valves, Drummond, McCall & Co., Ltd., at $9.85, $16.85 and $28; cast iron pipe, Canada Iron Foundries, 4-in., $54.50, 6, 8, and 12-in., $50; lead pipe Mechanics' Supply Co.; pig lead, Carne, Ltd.; clay pipe, Standard Clay Products; Cast iron, Terreau & Racine; total cost of contracts, $50,000.

Que., Almaville—F. X. Brouillette, Shawinigan Falls, Que., awarded contract (general) for construction of aqueduct system at $1,000.

Ill., Collinsville—Meyer Constr. Co., St. Louis, awarded contract for laying new water main from pumping sta. to Jefferson Ave., at $19,408. 10-in. main.

Iowa, Albert City—P. N. Cruse, Spencer, awarded contracts for pipe line, at $10,770; steel tower, tank, etc., to Chicago Bridge and Iron Wks., 3? W. Van Buren St., Chicago, at $4,600; Well, to Thorpe Bros., 209 Goodrich Blk., Des Moines, at $1,525; pump to Motor Haulage Supply Co., Mason City, at $1,025.

La., Bossier City—McCalm Bros., Shreveport, La., awarded contract (general) for water works at $34,954.

Mich., Port Huron—American Constr. Co., Marion Bldg., Cleveland, awarded contract for impvt. and bldg. addns. to water works system, including conc. intake well, intake pipes, etc., at $41,500.

N. Y., Watertown—Northern N. Y. Utilities Co., 58 Pub. Sq., let contract for conc. dam and penstock saddles at Browns Falls to Amberson Constr. Co., New York; wooden penstock to Wood Pipe Co., New York; installing water wheel to Willman, Seaver & Morgan Co., Cleveland; elec. generative and switchbd. equipt. to General Elec. Co., River Rd., Schenectady—total, $450,000.

N. C., Elkins—Meyers Constr. Co., Charlotte, N. C., awarded contract for water and sewer construction at $24,500.

N. C., Lexington—Tucker & Laxton Co., Realty Bldg., Charlotte, awarded contract for constructing water works plant (pumps and pipe line not included) at $96,000.

N. C., Mt. Airy—City will build by Day Labor 26x24x8 ft. rein. conc. coagulating basin, 250,000 gal. filter unit complete (filter shell now in place), 25,000-gal. steel or wood wash water tank on 30-ft. tower with 8-in. pipe riser, same to be frostproofed and 1 liquid chlorinating apparatus. C. M. Whitlock, City Hall, Engr. Prices wanted on material and equipment.

Ohio, Cleveland—P. F. Connelly, Kent, awarded contract for 20,000 ft. 6-in. steel mains in Ansel Rd., to Fairmount Reservoir at $510,607.

Ohio, Elyria—Hunkin Conkey Constr. Co., Century Bldg., Cleveland, awarded contract for 60x137 ft. water basin, conc., at $50,000.

Ohio, Euclid—A. Mara, Ulmer Bldg., Cleveland, awarded contract for mains in Dorsch Rd., at $17,-184; Victory Dr., Wood and Neville Rds., to B. J. Whittaker, 343 The Arcade, Cleveland, $7,307.

Okla., Oklahoma City—Following contracts let for iron pipe, etc., for water distribution system: U. S. C. I. Pipe & Foundry Co., bell and spigot pipe at $202,406; N. S. Sherman Mach. & Iron Wks., at $12,187 for special fittings for pipe and $870 for valve castings; Darling Valve & Mfg. Co., at $22,-154 for hydrants and valves.

Okla., Weleetka—Ladd Constr. Co., P. O. Box 6, Kansas City, Mo., awarded contract for constructing 5-mile pipe line, low-lift pump station, 500,000-gal. per day water purification plant and clear pumps, 1 mile transmission line, overhauling elec. distribution system and 25 pole white way, at $72,005.

S. D., DeSmet—O. N. Gjellefald Constr. Co., Forest City, Ia., awarded contract for water works system, including 23,550 lin. ft. 6-10 in. Class B c. i. pipe, 21,000 lbs. specials, conc. or steel tower, 150,000-gal. capy. pumphouse, conc. well, etc.; also sewerage system, at $95,500.

Tex., Houston—Chas. S. Basham, awarded contract for erection of settling tanks at Houston Heights and West End plant, at $13,400.

Tex., Jacksonville—Contracts for water works let as follows: E. P. McElrath, Corsicana, at $49,-363 for Contr. No. 1; Robert C. Newcomb, Dallas, at $29,994; U. S. Cast Iron Co., Dallas; Darling Valve Mfg. Co., Williamsport, Pa.; Briggs Weaver Mfg. Co., Dallas; Maury & Maury, Dallas; Des Moines Steel Co., Pittsburgh, Pa.

Tex., Marlin—Hess & Skinner, Dallas, awarded contract for constr. of dam and spillway at $58,867.

Va., Norfolk—Fred Jones Dredging Co., awarded contract for submerged pipe across Elizabeth river from Craney Isl. to Lamberts Point filter station, at 48c a yd. for dredging; for laying pipe, contract let to Sanford & Brooks at $14.50 a ft. Total cost, about $60,000.

Va., Richmond—Virginia Equipment & Supply Co., Richmond, Va., awarded contract for water main at $89,965 and at $18,660 for gas main.

Wis., Delavan—Swords Bros., 7th St., Rockford, Ill., awarded contract for exten. to water works, including ½ mile 8-in. force main, pumphouse and 30-ft. open well, at $16,782.

Wis., Milwaukee—Contract for 6,900 tons c. i. pipe and 30,284 tons special castings for force main in Chambers and 29th Sts. (a) straight (b) lugged (c) special castings, to U. S. Cast Iron Pipe & Fdry. Co., 122 S. Michigan Ave., Chicago; (a) $40.85 per ton, (b) $60.86, (c) $118; 54-in. main in Chambers St., to W. T. Warner, 675 Hi Mount Blvd., $76,235; 36-in. main in 29th St., to L. J. Stevenson, 1720 Cedar St., $17,080.

Prospective Work

ROADS AND STREETS

Ala., Attalla—City plans expendt. of $125,000 for purpose of paving 30 blocks; bitum. macadam, penetration method.

Ala., Tuskegee—Government will construct roads and bridges from city limits to site of U. S. Veterans' Hosp. to be built. $200,000 available. Jas. R. Fain, Supt. Rd. Constr. for Treasury.

Ark., Pine Bluff—City Commrs. Paving Dist. No. 59 plans expending $60,000 to pave 25 blks. in Hickory, Cypress, Plum and Cedar Sts. Guest Engrg. Co. Engrs. City Commrs., Paving, Curb & Gutter Dist. 57 will pave 18 blocks on 14th Ave., Oak, Beech and 11th Sts.

Ariz., Phoenix—E. S. Wheeler, Engr., Dist. No. 13, Phoenix, U. S. Bureau Pub. Rds., has ordered surveys for approx. 113 mi. rds. in Arizona and New Mexico, to be built with fed. funds. New Mexico projects are as follows: Canyoncito-Pecos, 18 ft. surfacing, 12 miles; Cimarron-Toas, 18 ft surfacing, 18 miles; Silver City-Reverse, 16 miles, 14 ft. wide with surface. Arizona projects: Prescott-White Spar, 18 mi.. Est. cost, $500 per miles; Ashfork, 26 miles to boundary of forest reserve; Flagstaff-Angell, 23 miles. Total est. cost, $1,250,-000.

Cal., San Diego—Council has adopted resolution of intention for street work as follows: E Street —30th to 31st Sts.—to be improved by grading, constructing conc. walks, curbs and 8-in. cem. pipe culvert; State St.—Redwood to Quince Sts.—to be graded and paved with one-course cement concrete; portions of Grade and Dront Sts., to be improved by paving with asph. conc. wearing surf. on asph. concrete base; also one course conc. in certain sections; constructing conc. walks and culverts. Third St.—Walnut to University Aves.—to be paved with asph. conc. wearing surface on asph. conc. base; portions of 8th and A Sts, to be im-

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Blossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

proved by paving with asph. conc. wearing surf. on em. conc. base, constructing curbs, house connec- ion sewers; Roosevelt Memorial Dr. bet. Pueblo ot 1286 and existing pavement at ft. of Biological Grade, to be improved by grading, paving with one course cem. conc. and constructing cem. conc. bearms.; 35 ft. 18-in.; 27 ft. 24-in. and 30.75 ft. 60-in. corr. iron culvert; Iowa St.—University to Polk Aves.—to be paved with asph. conc. wear- ing surface on asph. conc. base; Torrey Rd.—Pros- pect Pl. to Princess St.—to be improved by grad- ing, paving with one course cem. conc., construct- ing conc. curbs, walks 52 ft. 18-in. corr. iron cul- vert; also 30 ft. of Roosevelt Memorial Dr., by grading and paving with one course cem. conc., constructing 50-ft. 24-in., 37 ft. 18-in. and 48 ft. 24-in. corr. iron culverts; Herman Ave.—University to Thorn St.—to be improved by paving with asph. conc. wearing surf. on asph. conc. base, construct- ing conc. curbs and walks; 12 ft. 16-in. conc. pipe, 19 ft. 16-in conc. pipe, 338 ft. 18-in. double strength conc. pipe, 12 ft. 15-in. corr. iron pipe.

Cal, Vallejo—$438,000 will be expended toward constr. of state highways in Solano Co. during 1922.

D. C., Washington—House passed Dunn bill ap- propriating $140,000,000 for road work for next two years.

Idaho, Pocatello—Four short links in constr. of North and South state hwy. will be finished this Summer. First of these is 2.75 mile stretch on Caldwell Blvd., 2nd, 2.91 mi. no. on Boise Hwy. Grade is to have width of 26 ft. and surf. 18 ft. Est. cost of two links, $32,219. Culvert draing. will cost abt. $2,000 additional. A stretch of more than 20 mi. bet. Tamarack and Council will be an- other of the main links to be finished. Nine miles bet. Lucile and White Bird, along canyon of Sal- mon River, will also be built this summer.

Ill., Peoria—Ten miles hard rd. will be built from Canton East to Peoria and 10 miles from Rushville toward Beardstown this summer; also 6 miles no. of Macomb on Monmouth Rd. within one mile of Good Hope.

Kans., Wichita—Definite action toward paving No. Lawrence Rd.—City limits to Sedgewick-Har- vey Co. line—taken by Co. Commrs. when they passed two resolutions asking St. Hwy. Comn. to take immediate steps toward regrading grade crossings of Santa Fe and Frisco Ry. roads no. of City. M. Roseberry, Co. Engr., announced that County expects to let contract for the paving be- fore July 1st. Proj., including 1 r. r. viaduct, will cost approx. $600,000.

Md., Baltimore—City Paving Comn. has plans ready for paving 55 streets. Est. cost $1,400,000. R. K. Compton, Chrmn.

Mass., Boston—Approx. $153,000 will be expended this Summer for resurfacing Humboldt Ave. and Blue Hill Ave., bet. Seaver St. and Milton line in Roxbury. Bitulithic surfacing. Mayor has also promised that, if funds are available, he will carry thru as far as possible the laying of new granite paving in Warren St.—Dudley to Grove Hall. He has also made tentative arrangements with Pub. Wks. Commr. J. A. Rourke for expendt. of an additional $80,000 for street repairs in North and West Ends.

Mich., Holland—City Engr. instructed to prepare plans and specfs. also estimate of cost on paving 7th St.—Lincoln Ave. to Pine, and then connect 7th and 8th Sts. on Pine and Lincoln. Macadam base and sheet asph. top dressing will be used.

Minn., Olivia—40 miles of road will be graded and improved this Summer in Renville Co. Co. Surv. J. M. Callahan; Co. Aud. A. O. Schmidt.

Mo, Columbia—Council has passed resolutions for paving Paris Rd., Melhourne St. and S. 5th St., with Kentucky Rock Asphalt. It is hoped to let contract in near future.

Nev., Carson City—Plans have been completed on Project No. 10, Robinson Summit to Illipah, White Pine Co., 15 miles grading and gravel surfacing; No. 44, Illipah to Pancake Summit, White Pine Co., 23 mi., grading and grav. surf.; No. 45, Frenchman's Flat, Churchill Co., 5 mi. grading and grav. surf.; No. 15 West Co. line to Vivian, Elko Co., 8.34 mi. grading; No. 22, West Co. line to White House, Eureka Co., 6 miles, grading and grav. surf.; No. 31, Eureka to Hayranch, Eureka Co., 12.2 mi. grading and grav. surf.; No. 4, 3 mi. no. of Carters to Holbrook, Douglas Co., 4 miles grading and 25 per cent surfacing. Plans being prepared for Proj. No. 26, Reno to Lawtons, Wa- shoe Co., 4 mi. grading and grav. surf.; No. 16, Battle Mtn., Lander Co., 8.5 mi. widening grade and gravel surf.; No. 46, thru City of Yerington, Lyon Co., 1.5 mi., 18-ft. conc. surf., thru City of Fallon, Churchill Co., 1.24 mi., 18-ft. conc. surf., Hazon to Wadsworth, Lyon, Churchill and Washoe Co.'s, 15.65 mi. grading and gravel surfacing. Sur- veys completed on Rd.—Hazon to Wadsworth, Lyon, Churchill & Washoe Co.'s; thru City of Yer- ington, Lyon Co. and thru city of Elko, Elko Co. Surveys being made on Dallon to Grimes Ranch Rd., Churchill Co., Rose Crj. to Winnemucca Rd. Humboldt Co. and thru City of Winnemucca, Hum- boldt Co. Geo. W. Borden, St. Hwy. Engr.

N. M., Roswell—City Council has passed pro- visional paving order, which, if carried out in its entirety, will result in 41 new blocks paving being built here

N. Y., Brooklyn—Board of Estimate O. K.'s pav- ing, grading and sewer plans, as follows: Paving with asph. (perm.) Bay 32nd at est. cost $10,900; regulating and grading Narrows Ave., $19,200; re- grading, recurbing and reflagging portion Hegeman Ave., $2,200; paving with asph. (perm.) portion Conselyea St., $6,300; regulating and grading Hins- dale St., $6,600; asph. paving (perm.) on portion 48th St., $8,700; paving with asph. (perm.) on Kenmore Pl. $7,000; asph. paving (perm.) on Ave. K., $10,500; asph. paving (perm.) on portion 19th Ave., $7,200; asph. paving (perm.) on 61st St., $7,600; asph. paving (perm.) on 71st St., $6,600; asph. pavement (perm.) Kenmore Pl., $8,500; asph. pavement (perm.) on E. 14th St., $11,000. Work in- cludes bitum asph. (prelim. pavement) from Gravesend Neck to line abt. 260 ft. so. of Ave. U; granite paving (perm.) on Dupont St., $11,600; asph. pavement (perm.) 50th St., $7,800; regulating and grading Kenmore Pl., $3,700; paving with asph. (perm.) Newkirk Ave., $4,900; paving with asph. (perm.) and curbing where necessary Kenmore Pl., $18,100.

N. Y., Poughkeepsie—City Engr. Lawlor esti- mates cost to property owners of new pavement on Main St. from river to Cherry St. at abt. $40,- 000 for cut granite blks. on lower Main St. and comb. of first quality street asph. on sides of street and cement for trolley rails from Wash. St. east to Cherry St. Total cost placed at $140,000 of which $61,000 is trolley company's share. Busi- ness men held special meeting to name committee to co-operate with City administration in having this necessary improvement made.

Ohio, Columbus—There will be 60 street constr. jobs under way this month, 39 of which have started. Plans and specfs. for 61 others have been approved and notices are being served. In addi- tion to these Council has asked for estimates on 63 more. Mr. Simpson, City Engineer.

Tex., Karnes City—Karnes County Rd. Dist. No. 4 will construct 14.54 miles 1-in. bitum. surf. on gravel and caliche base; 1,460 sq. yds. pave- ment; 1,400 cu. yds. concrete. Est. cost $325,000. O. N. Powell, Engr. Kenedy, Tex.

Tex., Laredo—Bonds in sum of $150,000 voted on favorably in Webb Co. for purpose of bldg. high- way from Laredo to Mirando City oil fields.

Tex., Sequin—Guadalupe Co. Rd. Dist. No. 5 will grade and gravel 3.7 miles, and hard surface 19.1 miles in County at cost of $120,000. Hess & Skin- ner, Engrs. Dallas for 3.7 miles. J. B. Williams, Co. Judge.

Va., Norfolk—Norfolk County Rds. & Bridges Comn., will improve Swamp Rd.; construct Atlan- tic Ave. from Va. Ry. crossing to Edmonds' cor- ner; macadam surface; construct permanent sur- face on Swamp Rd. from Edmond's Cor. to inter- sect. of Great Bridge Blvd. at Oak Grove Church; conc. Plans issuing $110,000 bonds.

Va., Petersburg—Approx. $2,000,000 will be ex- pended on impvts. here during next 12 months.

Wis., Milwaukee—City will pave about 200 alleys this Summer if plans of Bd. of Ets. are carried out by City Council.

Wis., Milwaukee—State will construct opprox. 200 miles concrete highways during Summer and Fall in Milwaukee and adjoining counties. A total of abt. 400 miles paved road will be built this year. A. R. Hirst, St. Hwy. Commr.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

WATER SUPPLY AND PURIFICATION

Ariz., Prescott—Bids will be asked in about 30 days for constr. of the Banning Crk. dam, to be built as an adjunct to Prescott water system. It will be of concrete constr., 20 per cent cyclopean mas. type, 292 ft. long, with wing wall sustaining the spillway 225 ft. long, 62 ft. high, 6 ft. at top with base, 42 ft. Est. cost $150,000. City Engr. A. J. Kline has prepared plans.

Cal., East San Diego—City Engr. has reported to City Council that est. cost of proposed water system will be $260,000. E. A. Rowe, Hydr. Engr., representing J. B. Lippincott, water expert, reported that distributing system as planned is scientifically correct

Cal., Santa Barbara—Montecito County Water Dist., having ests. made as to cost of installing and maintaining distributing sys., in newly created district. City Council of Santa Barbara considering proposal to sell District water from city's supply.

Que., St. Raymond—Plans being prepared for water works system to cost $250,000 for town. Engr. Lapointe, Baire, St. Paul.

Fla., Auburndale—$30,000 bonds voted here for water works. W. L. Mason, Clerk.

Ky., Newport—City has decided to enter into contract with Geo. Hornung, Civ. Engr. to supervise installation of a 6,000,000 gal. pumping engine at Newport pumphouse.

La., Lake Arthur—Town will construct water works and purchase power plant for electricity. $50,000 bonds voted.

Md., Cumberland—City will extend feed main, probably abt. 8,000 ft. of 36-in. pipe line. Jas. H. Fuertes, 140 Nassau St., New York City, Cons. Engr.

Mich., Detroit—Essex Border Utilities Comn. plans to supply border municipalities with filtered water which will come to Windsor, Ont., by gravitation thru 36-in. pipe. J. C. Keeth, Engr. Plans will have capy. of $35,000,000 gals.

Minn., Lake City—City Council has decided to lay 85 blocks water mains for purpose of providing additional fire protection and to give all residences in City opportunity to have city water. Est. cost of impvt. $53,000. Plans call for laying 32,000 lin. ft. 6-in. water mains with exception of 750 ft. 4-in. mains on Park St.; also for 61 fire hydrants in addn. to the 84 now in, and 42 cut-out valves.

Mo., Versailles—$81,000 bonds sold here; $60,000 for water works and $21,000 for sewers.

N. J., Ventnor—Ord. creating bond issue of $200,000 for impvts. to water works, passed on second reading.

N. Y., Buffalo—City contemplates construction of filtration plant, plans for which include large coagulating basin, 304x408 ft. long and 24 ft. deep. Basin will hold approx. 20,000,000 gals. It is divided into two separate parts so that either may be drained and cleaned without taking other out of service. There will be 40 filter units, each having normal daily capy. of 4,000,000 gals. Low lift pumping station will contain 5 electrically driven centrif. pumps with total daily capy. of 240,000,000 gals. There will be 2 tunnels, approx. 12 ft. sq., one for conveying water from present intake to filter plant, and other to carry filtered water from filter plant to Ward pumping sta. In 2 huge conc. basins there will be over 1,000 conc. columns for support of overhead struct, large number of which will be 25 ft. long. There will be approx 340,000 cu. yds. earth excav. Much of this excav. will be taken from area now under water and used as backfill in vicinity of filter plant.

N. Y., Syracuse—City plans to lay 4,000 ft. mains in various streets at cost of about $75,000. T. H. Mather, City Hall Engr.

N. D., Fargo—Plans approved for constr. of water mains. Job 2204 Water Main Dist. 2, 15th St. N. from 3rd to 5th Ave.; Job 2205, Dist. 1, 15th St. S. from 1st Ave., 2nd Ave. 3rd to 4th Ave., 16th from Front St. to 2nd Ave. Job 2206, Dist. B, 11th St. S.—10th to 11th Ave. S.; Job 2203, Dist. 1, 14th, from 10th to 11th Ave. A. R Watkins, City Clk.

Okla., Ponca City—City will extend water works system; install 1000 gal. per min. centrif. pump 250 ft. head, 100 h. p., 2200 volt, 3 phase motor; approx. 1200 ft. 10-in. cast iron pipe.

Okla., Thomas—Surveys being made for pumping plant and wells to cost $50,000. H. G. Olmsted & Co., 415 Oil Exchange Bldg., Okla. City, Engrs.

Pa., Philadelphia—City will soon take bids for furnishing and installing pumping units at Larners Point Pumping Sta., $35,000; also for quantity of patent sleeves, stop valves and water pipe, $12,000. C. E. Davis, City Hall Engr. City will also take bids in near future for installing ash and coal-handling equipt. at Queens Lane Pumping Sta. $25,000.

Tex., Electra—Attorney General's Dept. has approved bond issue of $80,000 for water works and $20,000 for sewers.

Vt., Petersburg—City will extend water and sewer systems, constr. streets. $200,000 available. L. Brownlow, Mgr.

Wn., Monroe—Bids will soon be asked for water works system. Detailed plans and specfs. being completed by Miller Engrg. Co., Burke Bldg., Seattle. W. H. Clark, Town Clk. Monroe. Proj. will a 1,000,000-gal. conc. reservoir, laying 6 miles 8 and 10 inch wood stave main pipe line; also 32,500 lin ft. 4, 6 and 8 in. wood stave distribution lines, 425 cu. yds. conc., 8,000 cu. yds. excav. in main line and 6000 cu. yds. excav. in distribution system.

W. Va., Fairmont—City may expend $1,000,000 for water supply system. J. Clyde Morris, Water Commr.

SEWERAGE AND SEWAGE TREATMENT

Ca., Long Beach—A. L. Ferver, Director Pub. Service, reports that plans for addition to sewage disposal plant at entrance to harbor will be completed within 60 days.

Cal., Riverside—Resolution adopted by City Council to construct san. sewer in Hayes, Myers, Taft, Galloway, Roosevelt, Magnolia and other streets in Village of Arlington.

Fla., Key West—City contemplates constr. of san. and domestic sewerage sys. Est. cost $620,631. C S. Williams, Acting City Clk.

Md., Harve de Grace—Election will be held to vote on issuance of bonds for construction of sewer system. Mayor confident $35,000 will build sewer.

Miss., Durant—City will improve sewer system, $20,000 bonds voted.

N. J., Camden—Street Comm. has recommended to City Council that sewer be constructed for elimination of Baldwin's Run in E. Camden at cost of $275,000. Mr. Farnham, City Engr.

N. J., Jersey City—Vice-Chancellor Griffin has signed order permitting constr. of intermittent sand filtr. and chlorinating plant, to be used in connection with sewage disposal plant at Boonton.

N. Y., Glen Falls—$225,000 bonds voted for about 18 miles san. and storm sewers. L. G. Boynton, Clk.

N. Y., Gloversville—Plans and specfs. completed by Harison P. Eddy of Metcalf & Eddy, Cons. Engrs., Boston, Mass., for impvts. to sewage disposal plant so. of City. Est. cost $100,000.

N. Y., Massena—City voted on $65,000 bonds for storm sewers in various streets. G. W. Dawes, Vil. Pres.

N. Y., Queens Boro—Final plans and specfs. have been sent to Corp. Counsel's office for constr. of trunk sewer for Blissville section of Long Island City. Sewer will cost upwards of $150,000.

N. Y., Syracuse—City may expend between $300,000 and $400,000 for a digestive system to dispose of sludge from proposed sewage disp. plant. Ord. to this effect introduced by Alderman F. J. Cooney.

O., Cleveland—City plans new sewage disposal plant. Est. cost $240,000. F. A. Pease Eng. Co., Marshall Bldg., Engrs.

O., Port Clinton—W. J. Sherman Co., Toledo, O., have been assigned the work of preparing prelim. plans and estimates of cost for san. sewers, intercepting sewers and sewage disposal for Pt. Clinton.

Okla., Stroud—City will construct san. main sewers and sewage disp. plant; probably vote on bonds. City, Mo., Cons. Engrs.

Pa., York—Plans and specfs. for proposed addns. to sewage disp. plant completed by Fuller & McClintock, Cons. Engrs., New York City. Dr Grove, Supt. of Dept. Pub. Safety, recommended adoption of the plans and specfs., which will be submitted to Dept. of Health for approval.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
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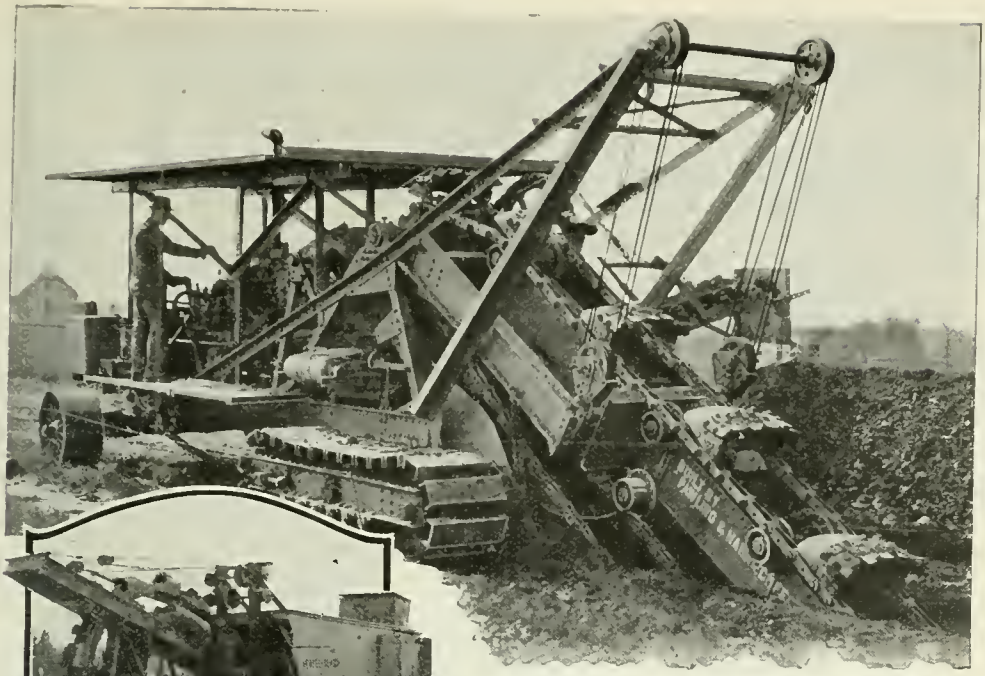

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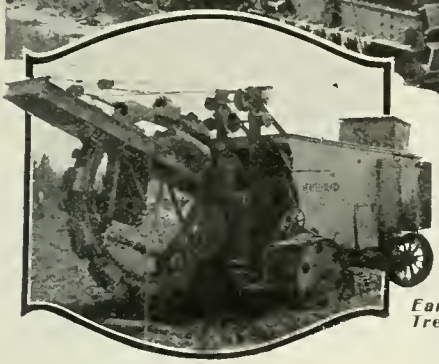

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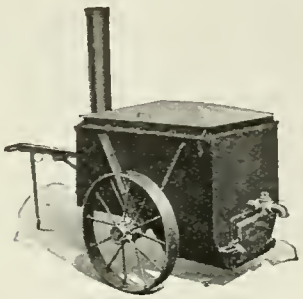

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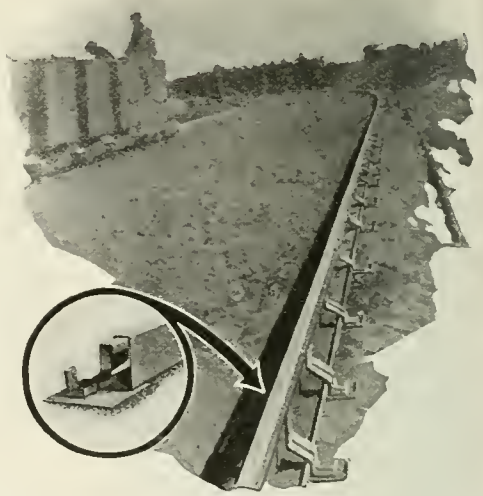

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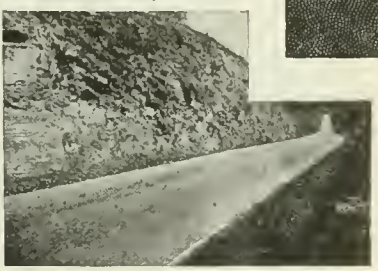

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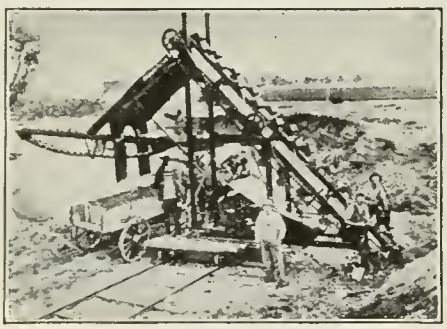

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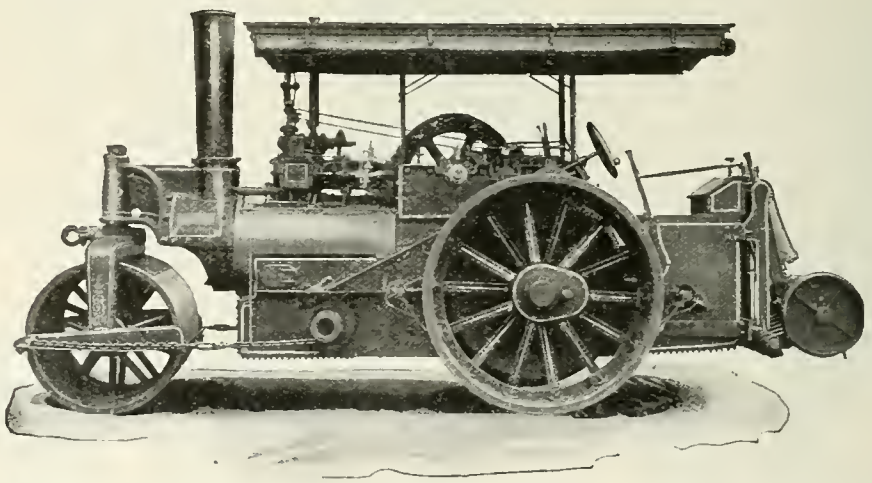

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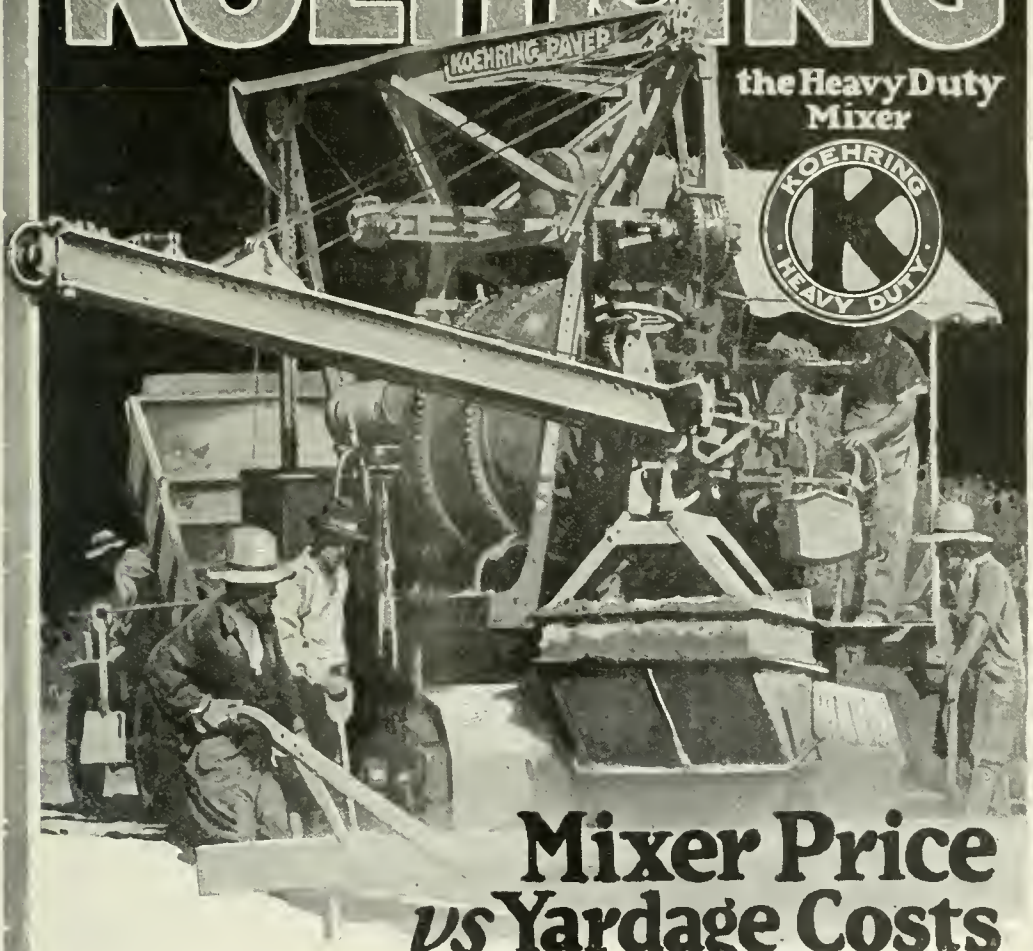

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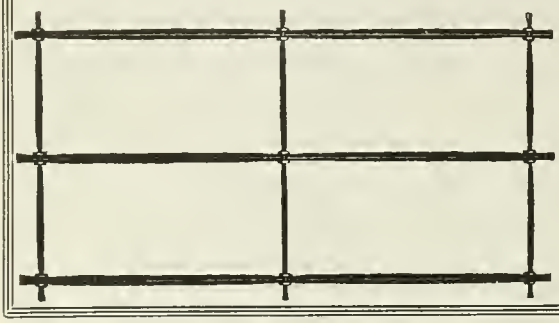

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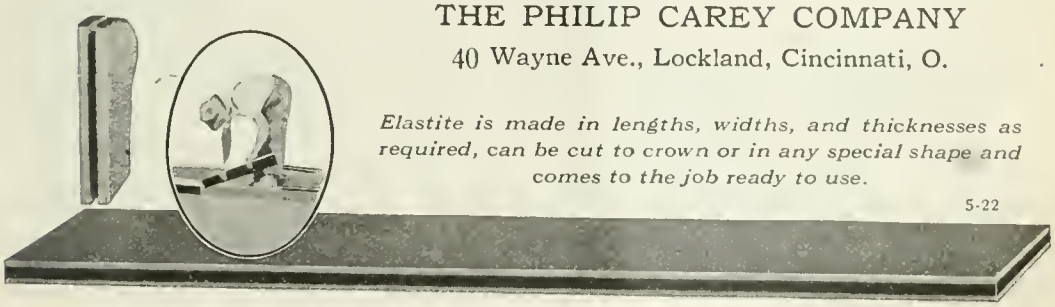

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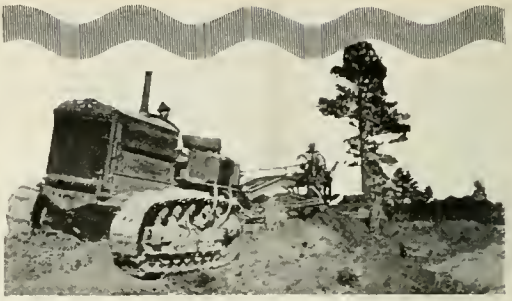

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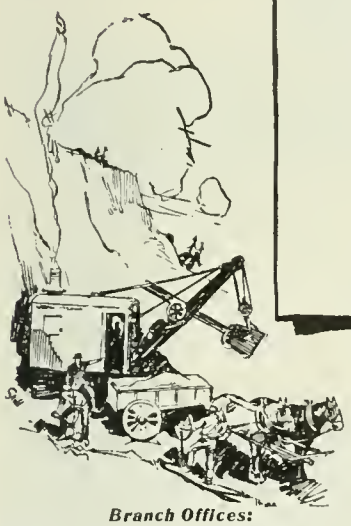

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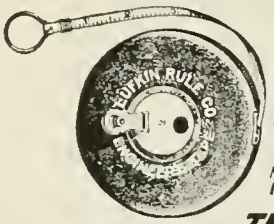

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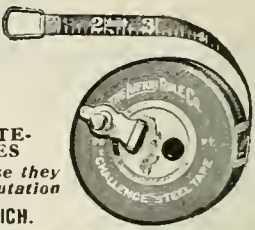

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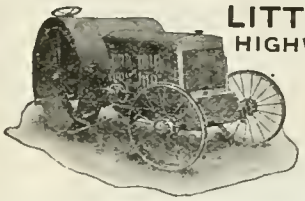

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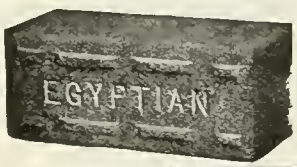

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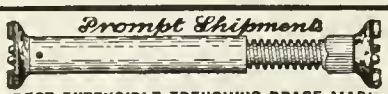

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Motor Truck Operation and Accounting—83

MOTOR TRUCK REPLACEMENT POLICY

The policy of the Nevada State Highway Department with respect to the replacement of used motor vehicles was stated in the June issue of this magazine. This is a very timely subject inasmuch as many of the motor trucks turned over to state highway departments by the federal government were used machines and many of these have undoubtedly outlived their economic usefulness. Commenting on this point the Nevada Department said: "Oftentimes the used machinery is good for about one season's use; then to repair and keep it in running condition is more expensive than to replace with new equipment." The general replacement policy of the Nevada Department is stated as follows: "We find that when the salvage value of a machine equals one-fourth of its original cost, and its repair to usable condition equals one-half its original cost, with continued operating costs about double that of a new machine, it is good business to turn the machine in on a new one."

Believing that this question is one of prime interest and importance we invited several men in the motor industry, in whose judgment we have great confidence, to comment on the general proposition with special reference to Nevada procedure. Extracts from their letters are quoted herewith.

"Motor truck replacement policies of the state and municipal highway departments must naturally be planned and carried out from a business standpoint. In this respect our governments can be no different from individuals.

"Trucks that are properly taken care of and for which parts can be secured immediately and at reasonable rates naturally have a much longer economical life than trucks which have not been kept in good condition and varieties which cannot be serviced properly in the districts in which they are located. The date on which a truck should be replaced can only be determined by its condition and the cost of maintaining it at full efficiency. It is going to vary with the individual trucks, the work they are called upon to do, and the care that is given them. That is about all that any manufacturer can say in regard to a motor truck without having a careful inspection made of each truck under consideration."

Commenting on the need for a well-considered replacement policy, another correspondent writes:

"Without doubt there will be a strong temptation on the part of highway officials of many states to keep down expenditures because of fear of incurring the displeasure of taxpayers, and at least some of these officials will carry the thing too far and actually spend more of the taxpayers' money for repairs to keep the old truck going, and then have nothing but a badly worn truck, than up-to-date machinery would cost."

That the economic life of the motor truck is much longer than the period usually assumed is the central idea in a letter from another authority. He writes:

"Having built only high grade motor trucks for over 20 years, we ourselves are not at all disposed to agree that any well engineered and built motor truck should be amortized in three to five years, as stated in the article on Nevada practice.

"Rather we claim that there are trucks so well engineered and built these days that if rationally operated and given reasonable care and mechanical attention, they should not, in fact will not, be worn out in any three to five years, but will instead be good and economical operating units in eight to ten years from the present time, and it has been our policy to preach the gospel of reasonable use and care with its resulting longer life and lower ton mile cost to the owner, instead of cheap quality and frequent truck turn over.

"The writer knows of no other line of machinery of any kind whatever, (unless it is for farmers' use, which is uniformly of very much different character and quality than motor trucks) in which there is any thought on the part of the purchaser that he will amortize any unit that costs as much as does a truck, in three to five years. Instead you will find that all kinds of machinery in thoroughly high grade shops run twice and even three times the length of time stated and are doing thoroughly good work. About the only exception that the writer can

think of to that general statement would be where high precision operations would be required, which demand a more frequent renewal of tool equipment.

"We can say to you frankly that we have out, not dozens, but hundreds of motor trucks operating now that were built as far back as 1910-1912-1913-1914. In fact, we are servicing such trucks all the time out of our present service stock which only goes to prove that the statement we have made is a correct one.

"To our way of thinking, first purchase price should cut no figure. Instead, the prospective buyer in his own interests should endeavor accurately to ascertain what will be his average annual ton-mile cost for transportation, figured over a period of six to ten years; such costs to include not only purchase price but operation, up-keep and annual amortization, together with loss sustained by lay-up of a truck and the inability regularly to carry on a man's business."

Another careful student of highway truck problems writes:

"There probably will be a temptation for state authorities to use motor equipment beyond the limit of its economic existence. This will probably be especially true of trucks received from the federal government. This would be perfectly natural, as having received these trucks with but a small item of expense, they have had the use of the trucks without incurring a large first cost and they will probably be disposed to continue the use of these trucks long past their period of economic use, rather than to involve the departments in the purchase of new equipment.

"The policy proposed by the Nevada State Highway Department seems like a very reasonable one. When a truck has depreciated to such an extent that its value is not to exceed one-fourth of the original cost and the expense of rehabilitating it is equal to one-half of the cost of the truck, I would say that the state would be amply justified in getting rid of that equipment to the best advantage and replacing it with new. In this connection three contingencies are possible:

"1. The truck may be sold for junk and new trucks purchased outright.

"2. It may be used in trade-in for new trucks.

"3. It may be dismantled in order to secure from it, for spare parts, such portions as may be available for that purpose.

"The state highway authorities are not only justified, but are in duty bound, to adopt such methods of disposal as would be for the best interests of the State Department. Just what course that will be may differ in different states and under varying conditions. This much is undoubtedly true that long before the highway construction plans now proposed are carried to completion the trucks granted to the states, and often by them to the counties, will have been worn out and new equipment of truck will be necessary.

"In securing that new equipment the State Highway Department should be guided by very much the same principles which direct the action of the commercial purchaser of trucks. They will have had a considerable amount of experience with motor trucks, should have learned how to operate them effectively and should have formulated some fairly definite opinions as to what trucks are best adapted for highway work and also should have learned from experience where they can expect most satisfactory service on their truck equipment. These considerations should direct them, it seems to the writer, in timing their purchases, in determining the manner of purchase, as well as the line or lines of motor trucks which they may select."

Additional comment on this important subject is invited for publication.

NEVADA PUBLIC SERVICE COMMISSION RENDERS GRADE-CROSSING DECISION

On April 25, 1922, on the application of the Nevada State Highway Department the Public Service Commission held a hearing on the matter of elimination of railroad grade-crossings on the state highway system. All rail carriers in Nevada and the Highway Department were represented at this hearing, and evidence introduced by both parties placed before the commission for the purpose of securing an opinion fixing a uniform rate of participation for the carriers on grade-crossing elimination. On June 14 the commission rendered its opinion on this matter, fixing a uniform rate for the carriers of not less than 33 1/3 per cent of the total cost of elimination, each case to receive special consideration. The following are significant paragraphs taken from the commission's opinion:

"The present state highway plans will be completed in about ten years, and

crossing separation will generally be made only as the development reaches the various tracks, this work being done in connection with the surfacing of the road in the locality. The number of crossings involved is not definitely known, as some of them have not yet been reached for intensive study, but the best figure now available is 52, and the elimination of some of these may be found unnecessary or impracticable. The separation of 52 crossings during the 10-year construction program means an average of barely 5 per year in the entire state. The proposed crossings appear to be pretty well distributed throughout the state, and would not seem to impose a serious burden on any one line.

"It is suggested by the carriers that the large appropriation made by the Federal government, on account of the great area of government land in this state which pays no taxes, should reduce the proportion to be paid by the railroads; that they should participate only in the portion of expense not borne by the nation. It seems, however, that it would make little difference to the carriers who pays the sum which is not assessed against them, whether it be the nation, the state, or a county, and this argument seems to be of little force.

"They complain that the state and national highway construction program is of no benefit to them; that in fact it will be detrimental because it will afford a competitive route for private and public automobile transportation; that, through the property taxes paid, their participation in the cost of highway construction and maintenance is heavy and that it goes to the benefit of their competitors. We must keep in view, however, that, in so far as automobile transportation results in an improvement in the art of rendering service, the public is entitled to the benefits thereof, subject to adequate regulation and taxation of these instrumentalities. On the other hand, the enlarged freight and passenger traffic and revenues flowing to the railroads from the enlarged use of auto-truck and stage lines is not of record, and, while it cannot be estimated at this time, the assumption is that these transportation agencies will give to the railroads as much or more revenue than they have taken from them, provided, however, that reasonable regulation is made against the paralleling of short-line railroads where the population and the traffic are small and the latter is necessary for the support of the railroad.

"It is not entirely clear whether the railroads consider a proportion of 12½ per cent or of 25 per cent reasonable, but in the absence of precedent, and on the record as it stands, we believe either of these sums too small. It is argued that the only method of assessing costs which would be fair to the railroad is to capitalize the expense of grade crossings, taking as a basis the amounts paid by the several carriers as damages for crossing accidents. There might possibly be some merit to this suggestion if we could know that the experiences of the past would be a fair guide to the future, but a crossing where there has never has been an accident may at any time be the scene of a collision attended with serious loss of life, causing the railroad to be involved in litigation resulting in the payment of large damage claims.

"It is impossible to foretell the monetary damage that may be saved a railroad by the elimination of any particular grade crossing. Aside from this, loss of life cannot be computed in dollars and cents, and the railroad owes a duty to the public which cannot be measured by or based upon a medium of exchange. It is suggested that the so-called "humanitarian" duty of the railroad is taken care of by its contribution to the general fund of the state through taxation, and that in this respect it stands on the same footing as any other citizen. This might be true were it not for the fact that the very element of danger which requires the separation of crossings has been incurred by the railroads in building and operating their lines over and along the public highways. One engaged in a hazardous occupation must provide for the safety of the general public and must, as a consequence, stand expenses which are not chargeable to all others.

"The question, therefore, goes to 'the safety of the traveling public and to the making of grade-crossing elimination, changes and betterments for the protection of the public and the prevention of accidents effective'; and to this end the exercise of the police power of the state is provided for in section 18a of the Public Service Commission Act (Stats. 1919, page 198).

"The carriers undertake to support their position in this proceeding by the contention that they pay from one-half to two-thirds of the total taxes in certain counties and an average of 38 per cent of all taxes paid by all property in the state. This position is seemingly untenable, for there is no constitutional

power, either national or state, under which an assignment of benefits can be allocated to a given class of property in proportion to the involuntary obligation which has been levied against it for the support of government. To hold otherwise is to say that property shall benefit in the exercise of governmental rights and privileges in proportion to the volume of taxes paid by each class, a wholly un-American classification of property and a restriction of the rights and liberties of individuals under our form of government.

"On the basis of the record before us and for the reasons aforesaid, it is impossible, under our statutes, to fix a hard-and-fast rule applicable to all cases. All that we can hope to do in this case is to establish a uniform rule, subject to variation in any particular case. In fact, it was agreed, at the hearing that it might be well to establish such a general rule "as a starting-point," fixing a percentage that will be fairly applicable to every railroad, whether rich or poor, and to every locality where such crossings may be established.

"In reaching a conclusion, we must accept the suggestion of 50 per cent made by the Highway Department, or find something between that and the 12½ or 25 per cent proposed by the railroads, which, we have already stated, is too low. Considering the financial condition of the state, the help it is receiving from the Federal government, the financial condition of the several railroads in the state, and the mutual value to the state and the railroads of eliminating crossings, after conference between railroad and state highway engineers on a program of construction extending over a period of ten years, and without unreasonable or burdensome capital outlays being required of the railroads in any one year, we are inclined to believe, and so find, that a participation of the railroads in the cost of eliminating grade crossings upon the state highway system to the extent of 33 1/3 per cent of the entire cost should be fair and equitable to all concerned, with the understanding that a variation of this percentage may be made in any particular case where the circumstances seem to justify a different finding. No order will be necessary herein."

ROAD SURFACES AND TIRE COST

"In the State of California," says the Richland, Wash., Advocate, "there are some 600,000 automobiles licensed. It is safe to say that the average machine, including trucks and pleasure cars, expends $100 each year for tires or an aggregate of $60,000,000 annually in this one state.

"It is safe to say that the annual depreciation on these tires is 20 per cent greater on a rough or gritty surfaced highway than it would be if such surface were covered with a cushion of some bituminous substance which not only would protect the foundation of the road but take the grind off the tires.

"In the one state of California this would mean a saving of $12,000,000 annually to automobile users for tires alone not to mention the saving to taxpayers through the longer life which would result to their permanent highways.

"Ten years hence, after various states have experienced the costly experiment of leaving the surface of their permanent highways unprotected by a non-jarring surface, public sentiment will be unanimous for that character of construction regardless of material used for the road base."

SOME COMMON INTERESTS OF HIGHWAY AND RAIL TRANSPORTATION

By Zenas W. Carter, The White Co., Cleveland, Ohio

(Editor's Note: That the highway, electric and steam rail lines have much in common is clearly set forth in this valuable paper by Mr. Carter, recently presented before the Central Electric Railway Association.)

A mighty wave of desire to "ride on rubber" has been sweeping the United States during the past few years. It seems fitting to call this desire of the public a "rubber urge" in transportation.

Just what the psychology is back of this wave, which is constantly increasing its size, is of less interest to the electric railway operator than the question of this influence upon his daily problem.

The electric railway operator is in the transportation business. He uses steel rails and electricity as his work tools. Theoretically he is interested only in steel rail and electricity.

Commercially and practically, however, he is in the transportation business, and the "rubber urge" is a feature of the transportation business. It affects both freight and passenger business. Motor

trucks and busses are here to stay. Their use is rapidly increasing everywhere and on every highway. They are essentially and actively an important part of the transportation business of today.

Thus, as a transportation man the electric railway operator finds his attention centering more and more upon the problem of co-ordinating motor trucks and motor busses with his electrical operation.

Just how this may be done to best cater to public demand to "ride on rubber" is an individual problem in each particular case. No general rule can be set up which will fit any two cases.

However, this much can be stated most emphatically—motor trucks and motor busses must represent an ultimate economy or they are a distinct liability.

Use of Motor Trucks and Busses by Electric Railways

This question of the economy of motor trucks and motor busses when used by electric railway companies has too many factors for any one to offer much more than a statement of some of the operations already underway. For instance, six months ago an officer of one of the Ohio electric railway companies made the statement that they were not interested in motor busses. At the present time this same company has determined that it will be economical for them to purchase (and their order has been placed) five special motor busses. These are to be operated on a highway paralleling their present lines.

Their decision was made from two angles entirely uninfluenced by the question of direct profit. In the first place, if they had not initiated bus operation covering the territory someone else would have started this service. Their franchise was in jeopardy because the public in the territory were not adequately served by the present electric service. Another factor was lack of capital to make the electric extensions, and their belief that the cost of additional track laying and equipment would be too great to prove a profitable investment at the established rate of fare.

Another company, the Northern Ohio Traction Company of Akron found, by careful study and survey, that there was an opportunity to keep competition from their electric lines and at the same time operate busses at a profit by initiating two bus lines, generally paralleling their trolley service at a distance of several blocks off track. On one of these lines there was already partial jitney competition, but this competition will soon be entirely eliminated by the action of the trolley company in purchasing high-class motor bus equipment and by their granting transfers from bus lines to the trolley cars.

An important factor in both these cases is also the opportunity offered by motor bus use to test the volume of traffic which may be secured, in advance of making an expensive installation. Furthermore, should it be necessary later either to abandon the lines or prove more profitable to install electric trolley operation, the motor busses will have a large salvage value or may be at once transferred to other service.

These two cases are cited particularly to illustrate that the question of economics in electric railway operation is not necessarily a question of making a specific profit on a definite installation of motor equipment.

On the other hand, there are hundreds of motor bus lines in operation in the United States in territory which was not being served by either the electric or steam companies. These hundreds of bus lines are delivering a profit to their operators. In some cases, as in California and a few of the Middle West cities, the patronage has already proven so profitable that passenger and transfer stations have been supplied by the bus operators.

Surveying Motor Bus Prospects

It is reasonable to assume that this business belonged to the transportation companies, either the steam or electric operators. As it is in outside hands, it is evident this transportation business was lost to the regular transportation companies largely through lack of interest in their making surveys for motor bus operation.

Several of the larger electric and steam railway companies have, however, checked over their prospective fields and are now actively in the business of catering to the public idea that it desires to "ride on rubber."

At Milwaukee, the Milwaukee Electric Street Railway Company made surveys which have justified their purchasing and operating 20 or more busses in co-ordination with their electric service. This action on their part has enabled them to conserve completely their investment in electric operation and to capitalize the "Rubber Urge" in making their extensions and in supplementing and supporting their normal service. In this way they have met conditions and fully satis-

fied the public demand for additional service.

Among the many street railway companies in the United States who have initiated bus service in co-ordination with their electric property operations are the United Electric Railways Company of Providence, R. I.; the Penn. and Ohio Elec. Ry. Co. of Youngstown, Ohio; the Rockford and Interurban Street Ry. Co., Rockford, Ill.; the Conn. Co., at various places in Connecticut; the Public Service Corporation of Newark, N. J.; the Street Railway Company of Baltimore, Washington, D. C.; Tulsa, Okla., etc.

Several of the New England Companies have already initiated bus service and in California the electric lines are both operating busses as individual companies and in co-operation and in co-ordination with independent bus companies in order to issue through tickets for long trips. At Niagara Falls, the Gorge R. R. Co. supplement their service by a bus operation; the Escanaba (Michigan) Power and Traction Company and the Northern Texas Traction Co. of Ft. Worth are also now on the list of users of both electric and gas motor bus transportation. At San Francisco and Seattle the Municipal companies are co-ordinating both types of service in carrying passengers. As an evidence of the very rapid increase in the use of motor busses throughout the United States and in support of the statement that the public is entbused over the flexibility, convenience, economy and utility of the motor bus, it is most interesting to cite the fact that one manufacturer of busses has received orders for over 350 of a new model which was first announced to the electric railway and motor bus operators on Jan. 1, 1922.

As transportation men, the electric railway operators will undoubtedly be much interested and possibly quite surprised to know that an independent bus operator, Frank Martz, of Plymouth, Pa., carried more passengers per bus in 23 busses which he operated in Wilkes-Barre, Pa., in 1921, than were carried by the same number (23) of the busses operating on the Fifth Avenue line in New York city. The figures are: For Wilkes-Barre, 183,891 passengers per bus, for New York City 174,192 passengers per bus. In fact, the total passengers carried by Mr. Martz in the busses which he operates in Wilkes-Barre, Pa., territory was well in excess of four million passengers carried during 1921. Mr. Martz began hauling passengers in and about Plymouth, Pa., in 1910, and he reports that several of his busses have passed the 300,000 mile travel mark, that 8 have run more than 200,000 miles and that 20 have run more than 100,000 miles each.

Throughout the United States there are dozens of these independent bus operating companies, which have had a period of existence amply justifying the statement that motor bus operation is an economic transportation.

Mention should also be made of the rapidly increasing use of motor busses of special type to transport vacationists, tourists and business men into scenic and resort territory previously inaccessible on account of physical contours of the country and the seasonal feature of the traffic

Some Busses Go North in Summer, South in Winter

Motor busses may be driven over inexpensive highways and into hilly territory serving seasonal traffic and transferred to other territory at will. This frequently makes an operation very profitable through using these busses in service in the North in summer and in the South in winter.

Last year on a trip from Chicago to the Pacific coast the most impressive single feature of the entire distance was the ever-present motor traffic. Whether we went west along the well known routes of travel or toured as we did into the very interior of Utah, in one case going to the north rim of the Grand Canyon 202 miles by highway away from any railroad, there was always motorized traffic passing in both directions, citizens in passenger cars, motor trucks and motor busses.

There were cars from almost every state in the Union, and motor trucks carrying almost everything conceivable from live stock to miscellaneous merchandise. Certainly no one thing could more emphatically demonstrate the fact that we are in the process of motorizing our highways, and that the "rubber" transportation of today is a new economic force in this service.

When we arrived in California the traffic increased tremendously, motor trucks and motor busses operating everywhere in addition to the thousands of passenger cars, further compelling recognition of the value of good roads in this process of motorization.

With the thought in mind that motor vehicles have been in successful operation and on an economic basis for such a short while, at best less than a period of one generation, it is difficult fully to real-

ize the great revolution which has come in our highway transport.

Our steam railway and our electric railway operations have been largely revolutionized during this same period through the development of the several types of motive forces. The application of these same power forces to industry, electricity, steam and gas has changed our entire country from a manual institution into a mechanical institution.

In a measure, motorization of our highways is likewise a change from a manual to a mechanical method of highway transport. Until the advent of the modern motor vehicle there had been very little progress made in the type of road vehicle in use since the days of the Roman road and the Roman horse-drawn chariots. What little progress had been made was merely in the character of the load-carrying device. The motive force was still physical power and not mechanical.

With almost 11,000,000 motor vehicles already on our highways it will be just a short time until all individual highway transport will be by motor.

The Ultimate Return to the Rail Interests

This is the logical step for this generation. It is the absolutely necessary step in the evolution of mankind. The steam railways and the electric railways will reap a return ultimately from this motorization as it will tend still more closely to knit the country into a corporate economic unit to promote quick exchange and rapid interchange.

While at the present moment, in some isolated instances, the advent of the motor truck and the motor bus may seem to initiate a new competitive unit and ultimately there may be members of lines of steam, electric and motor busses serving in the same community—the motorized vehicle will always be used for a type of economic transportation which, in general, is not competitive with either steam or electric operation.

It is an important fact that the motor on the highway offers the opportunity to supply the public with both local and express service operating over the same route, while this is impossible on single line rail.

Paralleling Rail Lines

It is very probable that a great many electric railway companies could profitably operate bus lines paralleling their rails, especially in congested centers, operating the bus lines for express service and using the electric service almost entirely for local stops. In many cities it would be possible to secure 10 ct. fare rates for such improvement in service and thus turn into a very profitable operation a franchise which carried so much long haul traffic as to be otherwise unprofitable at the usual 5 ct. fare rate.

In other cases such a service might solve a rush hour congestion problem profitably where the addition of extra cars would only tend to slow up movement and increase congestion.

Another field for the use of busses, in conjunction with electric line operation, is in territory where development has spread the area served until a large percentage of possible short haul passenger business is lost on account of the distance the passenger must initially walk to reach the trolley.

The use of busses covering such a section over what might be called a curved or bow route paralleling the trolley service at some distance but not operating on exact trolley schedule would often prove distinctly profitable and preserve the existing company from possible competition.

The picking up and delivering at curb, whether in urban or in congested city territory, is a psychological element to consider in the opportunity to increase short haul traffic.

The Lure of the Jitney

As previously stated, an interesting phase of the great increase in the use of the motor bus is that the public has, through ownership of motor cars, been educated to "Ride on Rubber." Probably this, as much as anything else, is the real reason why men, women and children will jam into and overcrowd the "jitney" and seem to prefer it in many cases as a means of transportation, even in places where the "jitney" service is paralleled by the electric railway.

It is largely the people who do not own cars that prefer the "jitney." It seems to be a vehicle of which the rider is more intimately a partner than in the trolley. The psychology of the entire situation is a vital factor. This is the "urge" back of the increasing use of busses.

In the motorization of our highways the motor truck has been ranking next to the passenger car in importance up to the present time, but it is very probable the use of the motor bus will soon exceed even the use of the truck in the revolutionizing of our highway transport.

The Question of Motor Vehicle Taxation

In this, it is very pertinent to comment on the subject of agitation in some sections to have the motor vehicle more heavily taxed.

Fundamentally, this is moving in the wrong direction except in so far as all vehicles using the highways may be taxed in proportion to their proper share of maintenance. As figures given later will show this is already accomplished.

The motorization of our highways is itself the economic force which has compelled the betterment of our highways and to increase taxation of this special class group would seem to tend to drive backward instead of forward.

While the motor vehicle automatically demands good roads and the use of motor vehicles increases in proportion to the improvement in the mileage of good roads, the all important point is that the mass citizenship is bettered by the improvement of roads, as it is an old adage that civilization and development follow improvement of transportation facilities.

Even the interests of the steam and electric roads may ultimately be served better by low taxation of motor vehicles than by high taxation. The steel rail carriers, both steam and electric, are the transportation industry. Sooner or later they will own and operate their own motor truck and motor bus lines, probably using trucks very extensively in store door delivery which is beginning to be demanded by merchants and wholesalers; and motor busses for the economic handling of their short haul and local passenger business and to supplement and probably, in many congested districts, to support or supplant already established lines.

In fact, as there are now dozens of electric railway and steam railway companies who own and operate both motor trucks and busses, they are just as much interested and will be more interested in the future in keeping down the taxation on motor vehicles as will the makers of motor equipment.

Boomerang Taxation

For this reason, it seems fitting that all transportation interests—the electric railway and steam interests as well as the motor interests—can well refrain from agitating for taxation which may ultimately tend to become a boomerang tax, and thus, prove burdensome to their own operations. Especially is highway tax agitation futile when it merely tends to widen the transportation cost breach existing between consumer and producer and as well to reduce the volume of goods which may be transported by motor for short haul and thus increases the unprofitable short haul tonnage to be handled by the railways.

Webster was Saying It Back in 1843

The improper use of highways by overloading motor vehicles should be denounced and effective legislation enacted to curb this practice; but the statement made by Daniel Webster at the Rochester, N. Y., Agricultural Fair on Sept. 24, 1843, is just as true today as then—"That one great duty of the Government is to see that the products of our rich soil and industrious labor may be easily, speedily and economically transported to the place of consumption and sale." Certainly the motorizing of our highways is a big step in furthering that end and government might properly subsidize the increased use of the motor vehicle rather than penalize its use.

The use of the motor truck by the electric railway service departments has naturally been proven economical as a factor in trolley operation much quicker than the use of the motor bus by the passenger departments.

In this service for public utility corporations, there are as many different kinds of uses for the motor truck as there are different types of work to be done. They are so varied it would be impossible to name them all.

Motor Truck Uses in Electric Railway Service

A few statements of their service to the electric railway industry will suffice to suggest the possibilities: First, in importance, is undoubtedly speed in repair work. The public will forgive almost anything except delays. When a break in a regular service occurs almost anywhere in the country the first call is for a motor truck repair outfit. Day and night they are kept on guard.

Emergency tower trucks speed at 25 to 50 miles per hour to repair line breaks. At one of the Georgia Railway and Power Company's substations, for instance, a motor truck was used to move a 20 ton converter into position in the substation.

Where cable is to be strung on lines or go into conduit, the truck equipped with power is indispensable both for use in loading and unloading the reel at the warehouses and for paying out the cable or drawing it through conduit in the field.

Poles are carried into the field. Frequently the power of the truck or the winch is used in setting them up greatly conserving the number of men required for this work as compared with the old method. Cross arms, insulators,

transformers, tools and men all accompany the construction—often enabling one crew and one truck to perform work formerly requiring a number of teams and two or more crews.

Where excavation is required they are always on the job with tools, materials and men—dependable in all weather, durable through merciless punishment and most economical as well.

Where series of wires are to be strung on pole lines, some companies have rigged the trucks with special racks, feeding from eight to ten wires at a time, carrying all cross arms and insulators required at the same time. Many times trucks have been used by power companies to move buildings on their property.

Electric railway companies, in a number of cases, have had cranes mounted on motor trucks to assist in construction and repair work and to give speedy aid in removing obstructions if a line is blocked.

Motor trucks are used for patrol work; to haul fuel; to transport men and material on every kind of work, and anyone familiar with the field needs of electric trolley can specify dozens of other uses.

In addition to the tremendous value which the motor truck represents in the service departments of the electric railway field, there is a use for trucks for supplementary freight service which may soon grow into large proportions, for the extension of electric railway freight lines into off line territory, as has been inaugurated by the Cincinnati, Aurora and Lawrenceburg Electric Railway Company. Finding themselves blocked for freight delivery and receipt at a point located five or six miles from the business center of Cincinnati, they have adopted the use of the demountable body or uniform container in use by the steam railroads of Cincinnati. They have established a service which enables them to meet steam railway competition and to give store door delivery. Arrangements were made with the Cincinnati Motor Terminals Company to supply them with their specially designed container truck bodies and to supplement service from their outside terminal to the heart of the business center, by using these truck bodies on flat cars instead of using box cars for freight. By this system, the truck bodies are immediately removed from the flat cars of the electric railway company just as soon as they arrive at their terminal. The Motor Terminals Company immediately takes them on its trucks, of which a large fleet is maintained in Cincinnati for steam railroad service. This enables the electric railway to make delivery to the off track downtown terminal within a few minutes after the arrival of the flat cars at the outside electric terminal. Or, when the consignment is in quantity it may be delivered direct to store door or warehouse of consignee in record time and without rehandling.

By this same method, the container bodies are filled for out-bound service at the off track terminal in the heart of the city and transferred by motor truck to the electric terminal. Delivery to local way stations is then made direct from the container bodies carried on their flat cars.

This system not only saves much loss from damage, theft and misplacement, but it relieves the trolley company from much extra checking, rehandling, etc., and enables the trolley line to provide a service excelling that of any other transport. This system also is less expensive than direct motor truck haul in this case. A somewhat similar operation, using trailers, is in service in Chicago, as part of the freight system of the Milwaukee Electric Railway Company.

What the Motor Industry Pays the Government

As the question of contribution made to the public purse is a very important feature in any consideration of the subject of motorizing our highways, it is interesting to check up some of the dollars and cents facts. They are all very startling facts.

For instance, what man in the electric railway field, not definitely interested in the motor industry, is aware that the Internal Revenue Department of the United States received from the motor industry in the year 1921, the amazing sum of $115,546,299.31 as excise tax alone, and, in addition, the sum of $1,776,493.88 as excise tax on passenger vehicles for hire?

These millions are all in addition to the normal income tax and excess profit taxes paid by the manufacturers out of their profits as manufacturers.

In comparison, this excise tax alone, represents a sum almost one-half as much as the government received in returns from the tax on the transportation of all freight, all express and all passengers by all the steam railroad and electric lines in the country.

This motor industry contribution represents almost five times the government

collections in taxes on telephone, telegraph and radio messages.

Corporation returns distributed by industries are not yet available for the past year, 1921; but if the motor vehicle manufacturing returns merely equalled those of 1919, (and with almost 2,000,000 more vehicles registered last year than in 1919, it is reasonable to presume they exceeded 1919) then the motor industry contributed in income tax and excess profits tax, including motor vehicles and automobile bodies, but not including the returns from the tire and accessories industries, a total of $79,675,544.

This 1919 tax paid, was four times the total tax paid by all of the manufacturers of electric machinery, stationery and marine engines, refrigerating machinery, etc., combined.

These are governmental facts shown under Table 9 of Internal Revenue Department statistics issued in 1922 covering returns of 1919, and under Table 3, page 89, of the annual report of the Commissioner of Internal Revenue for 1921.

But that is not all which should be brought to your attention as this motor truck and motor bus industry relate to the financial side of our government revenues.

Motor License Fees in 1921

From the Department of Agriculture, Bureau of Public Roads, I have a tabulated sheet brought up to date and covering the year 1921, which shows that the various state governments, either as state revenues or as highway department revenues, received the grand total of $122,478,654.34 as gross motor vehicle and license revenues for the year 1921.

This tremendous sum, if applied solely to maintenance of highways (not new construction) would pay for all the maintenance necessary to keep our highways in perfect condition after they were initially paved with proper pavement to serve reasonable traffic, as it is estimated that 10 per cent per year of original cost will maintain any properly designed and properly constructed pavement for any class of traffic. This vast sum of over 122 millions would thus maintain an expenditure of over $1,225,000,000 for new pavement. No such sum has been expended for pavements, even if all the expenditures of all our states were combined with the contributions of the United States government for highway work.

Taken as a total sum contributed as income tax, excise tax, or as license revenue; the automobile, motor truck and motor bus provided a grand total of over $317,700,447 of revenue to the state and national governments in 1921.

It is a fact that this was indirectly contributed by every user and owner as well as by the manufacturer but the great total is an emphatic argument to direct universal attention to the extraordinary progress this country has made in a decade in local transportation. For, with few exceptions, all motor vehicle use, whether pleasure car, motor truck or motor bus, is local.

The total registration of motor vehicles for 1921, as shown by the tabulations of the Bureau of Public Roads, was 10,465,995. Of these, 9,342,844 were passenger cars; 982,604 were trucks and commercial cars; 50,547 were taxis and busses.

Facts for the Consideration of Electric Traction Interests

These figures are startling. They are very important in interesting the electric railway industry when compared with the statement from the January 7th issue of the Electric Railway Journal to the effect that there were 149.79 less miles of electric rail in service in 1921 than in 1920 and that the total of cars and locomotives in service was only 106,385 in 1921 as compared with 106,688 in 1920.

These figures are still more interesting when surveyed in the light of the increase in our population and in the general tendency to greater movement which came as the result of travel and change for so much of our population during the war.

These figures should be beneficial to the electric railway operators. Information often stimulates activity. Activity rightly directed usually increases profits, improves service, and broadens operations.

In the present situation as it relates to the use of the motor truck for carrying freight, in co-operation with the electric or steam railway and as it relates to the use of the motor bus or the rail bus for carrying passengers in co-operation with either, this new means of local transport offers an opportunity. It is an opportunity for the railway interests to be carried along into this new field of transportation.

Sound, careful, intelligent investigation will easily disclose to the interested railway operator that these almost 11,000,000 vehicles cannot now be superseded by systems of either steam or electric transportation.

More careful analysis will also un-

doubtedly show that in a majority of cases not only the passenger cars, but the motor trucks and motor busses as well have been used to take care of business and personal demands for a class of transportation which either could not be cared for by the steam or electric units or for a class of transportation which it would be actually unprofitable for the older system to handle at the rate which is profitable to the motor vehicle.

The motor truck for short haul freight service offers the opportunity to pick up freight and make delivery with just two manual handlings of the goods as compared with four handlings if the goods must be loaded into and taken from a box car.

In passenger transportation the motor bus offers a system supremely flexible which may be co-ordinated profitably with a system rigidly inflexible.

Ultimate "economy" is a Juggernaut. That which will give to the greatest number the most good for the least money is the system of transportation which the transportation fraternity must provide.

You are the transportation fraternity. The problem, if there is one disclosed, is entirely one of profit. Each unit used by the fraternity must produce a profit. Without profit to inspire there is no interest. Without interest, there will be no energy expended to provide service, for energy is born of interest.

Already many of the electric railway fraternity have been inspired by the profit in motor truck and motor bus operation. They have expended the energy necessary to investigate. The more carefully more investigate, the more rapidly will this new transport unit—the motor vehicle—be inducted into service as an integral part of electric railway operation.

TRAFFIC CAPACITY AND WIDTHS OF COUNTY HIGHWAYS

By H. C. Smith, State Highway Laboratory, University of Michigan, Ann Arbor, Mich

(Editor's Note: Following is the report of the committee, of which Mr. Smith is chairman, of the National Highway Traffic Association, as submitted at the Conference of the Association held in New York City on May 12.)

There has been a large quantity of statistical data compiled throughout the country in the nature of traffic censi and many traffic studies have been made to determine the future traffic for given highways. Most of such data is not of maximum value, however, in determining the desirable width of roadways for a given traffic, inasmuch as the variation in speeds of various classes of vehicles generally is not given consideration. Any computation of required width of roadway, based upon the assumption that all the traffic on a given highway outside of a municipality will travel at a common speed, should be used with great reserve as the assumption is obviously incorrect in all but exceptional cases.

For the greater part, highways outside of municipalities need have but two lanes of traffic to care for the traffic which they are called upon to accommodate. Highways leading into large municipalities or connecting nearby cities, however, present a problem that calls for careful solution inasmuch as they may and often do carry traffic that varies in speed from about 3 miles per hour to 35 miles per hour. In many cases the quantity of traffic approaches and often exceeds the economical traffic capacity of a two-lane roadway, although computations may show that the amount of traffic anticipated from traffic surveys could be carried adequately by a two-lane roadway if the traffic assumed to travel at a common uniform and properly selected speed.

Factors Governing Width.

In cases of highways which are to carry congested traffic, the designing engineer must give careful consideration to all functions of a roadway which should affect his decision in choosing the number of lanes of traffic to be required and the modification of widths of roadways and shoulders for any given number of lanes. The function of a roadway which thus affect the design of its width are enumerated as follows:

1. To provide a sufficient number of lanes to carry the traffic that comes upon it.
2. To provide means of allowing fast moving vehicles to pass vehicles moving more slowly, the speeds being within legal and operating limits.
3. To provide for the ranking of vehicles at the roadside in such cases as for necessary temporary repairs.
4. To be of such width as to discourage the taking of dangerous chances by operators of vehicles.

When a two-lane roadway has become so congested that it is impossible to operate a vehicle without considerable loss of time due to traffic delay, its economic traffic capacity has been exceeded. This degree of congestion occurs for a traffic count of a great deal less than that equal

to the computed traffic capacity of the roadway when variation in speed is not considered. As the amount of traffic or speed variations increase, the possibility of passing a slowly moving vehicle when it is overtaken becomes less. Ultimately, it becomes entirely impossible for vehicles to pass each other and all traffic must assume the speed of the slowest moving vehicle.

Results of Investigations

To emphasize the relation that should exist between traffic and roadway widths, the results of office computations and field observations of traffic operation made by the chairman of the committee may be of interest.

For one typical series of investigations for a two-lane roadway, a traffic of 750 vehicles per hour was assumed, 500 of which traveled in one direction, the remainder traveling in opposite direction. Three assumptions as to variation in speeds were made.

First—Three per cent were assumed to travel at 3 miles per hour, 10 per cent at 10 miles per hour, 57 per cent at 20 miles per hour and 30 per cent at 30 miles per hour.

Second—Thirteen per cent were assumed to travel at 10 miles per hour, 57 per cent at 20 miles per hour and 30 per cent at 30 miles per hour.

Third—Thirteen per cent were assumed to travel at 10 miles per hour and 87 per cent at 20 miles per hour.

Effect of Slow Moving Vehicles.

It was found under the first assumption that the meeting of two of the 3-mile-per-hour vehicles slowed down traffic each way along the road for a distance of one-quarter mile. The meeting of vehicles of various faster speeds affected the movement of traffic similarly but to a less degree. It was also evident that 750 vehicles per hour, two-thirds of which is traveling in one direction and under the first outlined assumption as to variation in speeds, could not be operated on a two-line roadway.

Under the second assumption of speeds, the meeting of two slow vehicles affected the traffic for a distance each way along the road of 300 ft., and the operation of traffic under this assumption was entirely possible.

Under the third assumption the traffic was shown to operate smoothly and the quantity could have been considerably increased.

The results of these computations were checked by observing the operation of traffic on roadways leading into Detroit, and the observed effect of varying speeds checked the calculations quite closely.

The foregoing results should be compared with computations based upon the assumption that all vehicles will travel at a common speed. Under logical assumptions as to clearance between vehicles, and assuming that all vehicles will travel 15 miles per hour, a two-lane roadway should carry about 2,600 vehicles per hour in each direction. If the speed is reduced to 3 miles per hour by a few heavy horse-drawn vehicles, the capacity is reduced to about 750 vehicles per hour in each direction. There can be no doubt, therefore, that the variation in speeds affects the traffic capacity and hence the required width of a roadway.

Quite obviously, a stalled car which, through inadequacy of shoulder design, is prevented from pulling to one side and hence blocks one lane of traffic, has the same or a worse effect on the traffic capacity of a roadway than a slowly moving vehicle. The roadway traffic capacity can be materially increased by adequate width and design of shoulders.

The safety of traffic should not be disregarded in the design of roadway widths. In the case of a two or four-lane roadway, every vehicle operator realizes just when he has the right-of-way and when he has not. The operation of a three-lane roadway, however, is not so simple. The center lane is not and cannot be reserved for traffic in either direction, so it must be left to each individual operator to decide whether he is more entitled to this lane than another operator going in the opposite direction. Such a width of design fosters danger to traffic.

Conclusions.

Your committee respectively submits the following tentative conclusions for consideration:

1. The design of roadway widths must give consideration to the economically desirable variation in speeds of the various classes of traffic.

2. Any two-lane roadway carrying intensive traffic should have a width of 20 ft. and should have 5 ft. shoulders capable of sustaining standing vehicles for temporary delays.

3. A two-lane roadway should be increased to a four-lane roadway when the traffic is reduced to the speed of the slower vehicles through not being able to pass, if the economic loss of time will justify the expense.

4. The building of three-lane roadways should be discouraged due to the danger to the traveling public.

PAVEMENT WIDTHS FOR HIGHWAYS SERVING LARGE CITIES

By William F. Cavanaugh, Milwaukee County Highway Commissioner, Milwaukee, Wis.

According to the census of 1920, we have in the United States today 12 cities with a population in excess of 500,000 people and 56 cities with a population between 100,000 and 500,000.

A large percentage of the more heavily populated cities today have hard surfaced highways radiating outward from their corporate limits that are entirely inadequate to handle traffic because of their narrowness, said Mr. Cavanaugh in addressing the American Road Builders' Association.

This is not due to a lack of foresight in most cases on the part of highway engineers but due mainly to the fact that these communities are not in a position to finance the building of a highway of a greater width.

Considerations Governing Width

In choosing the proper width to construct a new highway or to widen an old one it is sometimes quite difficult to determine what width is proper. We have to consider first of all the amount of traffic it takes before construction together with the expected increase it will afterwards be called upon to take. It may be that in succeeding years adjacent and parallel highways will be built and a certain portion of traffic will be diverted over them.

In starting construction at the limits of a city that part of the highway through the outlying districts often requires a greater width than further on due to a greater traffic on account of conditions being similar to city conditions and being more heavily populated than portions of the highway further on.

In these communities it is well to take the future growth or expansion of the city into account and plan accordingly adopting the proper alignment and grades so as afterwards to conform to the grades and alignment of future intersecting streets. Drainage structures should also be planned with this end in view.

In the event that a highway is to be paved 20 ft. wide with the intention of later increasing this width it is well to construct the 20-ft. width to conform to the center line of the right-of-way and not make the mistake that some communities have in building along the old roadbed which deflected here and there from the center line. The main idea of course in so doing was to cut down on the grading cost and obtain a more solid foundation. Afterwards when these territories build up and the traffic increases it becomes necessary to widen the roadbed and it cannot be uniformly widened on each side and the result is the proper crown cannot be obtained on the new road and there is not a uniform sidewalk space. Additional right-of-way has to be purchased.

Highway Lighting

An 18 or 20 ft. highway is especially hazardous for pedestrians at night time where highways close to a city are not illuminated. Most states have regulations regarding automobile headlights but the lack of illumination has been the cause of a great many accidents where autoists have run into and injured or killed pedestrians. We have some of our highway in Milwaukee County illuminated and expect to continue this work each year. We are using ornamental concrete poles with the bracket light and the cables laid underground. Unless these lights are elevated to a height of at least 25 ft. there is a very noticeable glare on the eyes of the passing motorist.

Sixteen-ft. Roads Inadequate

Most of our 16-ft. roads today are inadequate especially so when there is any amount of truck traffic and the major portion of our highways are being constructed 18 or 20 ft. wide. This width suffices to care for two lines of traffic. Some consideration should be given to the matter of constructing a 30-ft. width which does not provide for more than three lines of traffic. We often speed up to pass the car in front and doing so may frequently meet another driver doing the same thing coming towards us and the result is a head-on collision in the center. It almost seems that in providing increased widths we should provide for either two, four or six lines of traffic.

The Use of a Curb

I believe the use of a curb is warranted on wider roadways as the fills do not have to be constructed as wide and the shoulder width can be cut down especially through the cuts, doing away with ditching; the drainage structures do not have to be built as wide and less right-of-way is necessary. It is clearly not good engineering to provide either inadequate or extravagant widths and it is often the case that a pavement 3 or 4 ft. narrower than the one laid would serve all the purposes of the wider one or an additional

3 or 4 ft. to a pavement along a highway especially with a car line will provide for two extra lines of traffic. Pavements are expensive to lay and should therefore be only sufficient to provide for traffic needs during the life of the surfacing.

The blind acceptance of right-of-way widths irrespective of the various uses to which streets are being put is especially unwarranted in the outlying parts of the city where houses are just beginning to be built and where the widening of main lines of travel would be comparatively cheap.

Experience the world over teaches us that old highways must be widened when the opportunity arises but a community without a definite plan or program lets these opportunities for widening pass by.

BRICK CONTRACT AWARDED ON AN ILLINOIS STATE HIGHWAY

Contract for construction of the first brick road to be built by the state of Illinois since Governor Len Small's "$30,000 a mile" edict went into effect, has just been let by the Illinois State Highway Department. While smaller political units in the state have been building brick roads right along, this is the first action of its kind on the part of the state highway department, under the present administration.

This follows closely a similar action on the part of the Indiana State Highway Department. Indiana, however, was one of the last states in the union to establish a highway department, and while many miles of brick roads have been built by the various counties in Indiana the recent contract by the state was the first since formation of its highway department.

Thus two states which rank high in proposed mileage of modern, improved highways have put their official stamp of approval on vitrified brick for highway surfacing after a more or less extended period of concentration on other types.

The Illinois contract, let to J. E. Craine of Murphysboro, Ill., is for 13.32 miles on Route 2, sections 12 and 13, extending from Cobden to Dongola, Ill. Specifications provide for a base of 10 ins. of Novaculite, laid in two 5-in. courses, a 1½-in. sand cushion, 3-in. vitrified brick and asphalt filler. Curbs of compacted Novaculite will be 12 ins. wide and 4½ ins. deep. The pavement will be 18 ft. wide.

"Novaculite" is a trade name of a local material found in Southern Illinois which is a silica product, or what some engineers call disintegrated chert. It contains alumina and oxide of iron, commonly called "clay binder" and when rolled and compacted sets up hard with cementing characteristics. Like crushed stone, slag, or gravel where available, it is looked upon as a good base material when a rolled base is desired.

The Cobden-Dongola road is a portion of one of the principal north and south highways of the state which, starting at Decatur, runs due south through Pana, Vandalia, Centralia, and Carbondale to Cairo, on the Mississippi river. When completed it will be one of the heavy traffic routes of the state.

In Indiana the recent brick contract was for a 6.89 mile section of the heavily traveled and widely known National Road. There too, 3-in. brick and asphalt filler were specified.

NORTH CAROLINA HAS SCHOOL FOR HIGHWAY INSPECTORS

North Carolina, in carrying out its $50,000,000 highway program, has introduced a departure that promises to set a swift pace for other states to follow. As a means of qualifying its inspectors for the inspection of bituminous paving the North Carolina State Highway Commission, through its Division of Tests and Investigations, has established a short course in bituminous laboratory and plant instruction. The course is necessarily a short one and consists of taking the men into the laboratory for about a week to learn the different tests of the materials used and to attend lectures by the supervisors of this type of construction. After the laboratory and lecture courses are over, the men are taken to the asphalt plant for instruction in the duties of the plant inspector and then on the road for instruction regarding the construction methods to be used.

The men for this work were secured mostly from the different districts into which the work of the State Highway Commission is divided. The number of men from each district is proportional to the amount of this class of construction to be carried on. This will allow the men to be located in the same district they came from, and the only need for any change would be in the demand for emergency inspection from another part of the State.

EDITORIALS

EYES AND THE PEDESTRIAN

A prime cause of automobile accidents lies in the fact that many pedestrians have not yet learned to think in terms of motor traffic. In other words the "wheels in the head," about which we heard much some thirty years ago, have not yet been equipped with rubber tires. More specifically, too many people forget to use their eyes and depend entirely for their safety on their sense of hearing.

In the old days when traffic was horse-drawn and iron-tired it was noisy and moved slowly. The pedestrian, even though asleep on his feet, was awakened by the grinding of the iron on the roadway or by the clatter of the horses' hoofs, and had plenty of time to get out of the way. Now traffic moves swiftly and quietly; it steals up on one with what Arnold Bennett might call "the imperceptible stealthiness of a bad habit." The sense of hearing is not sufficient to protect one in crossing a street, for the noise made by an approaching motor vehicle is often indistinguishable from the hum of the city. The safe plan is to look both ways before stepping into the line of traffic and then give the right of way to everything on wheels. Railway track men, and others who have occasion to walk on railway tracks, learned this lesson long ago.

IN DEFENSE OF THE TALKATIVE FEW

In an editorial on: Why Engineers Stay Home, a contemporary journal recently made out a strong case against the "time-wasters" who do so much talking at engineering society meetings. It is quite possible to agree that a few do all the talking, not only in engineering meetings, but in the general run of meetings of business and professional men of all classes, even in the United States Senate, and still reach more than one conclusion about the best remedy for this unfortunate situation. If the talkative few should suddenly become quiet, assuming that this is possible, it does not by any means follow that those who had been content with thinking parts would as suddenly become vocal. In fact, we have observed on a number of occasions when those who usually "do all the talking" were absent, or silent, that those who usually remained silent kept right on remaining silent. For example, water works superintendents often complain that the consulting water works engineers do all the talking at the water works conventions. Some years ago this feeling threatened to disrupt the American Water Works Association. When it came to the attention of the engineers who had been doing so much talking they suddenly became comparatively quiet. Did the superintendents seize the opportunity to start talking? They did not. They remained silent and the chairman of the meeting was forced to call on individuals for expression of their opinions in order to keep the proceedings from dying out entirely.

While those who talk undoubtedly appreciate the value to themselves of being active in this particular, it is also true that, in the great majority of cases, they want by this means to promote the "good of the order," to assist in the advancement of knowledge, to encourage others to talk, to make the meetings interesting, etc. On the other hand it should be recognized that those who remain silent do so from choice and not from necessity. We do not recall a single case, in many years' attendance at engineering society meetings, where the chairman refused to recognize any member who wanted to address the meeting. The chairman's greatest problem is to get somebody to say something, rather than to squelch the few who are able and willing to talk. So, while we admit that discussion is often prolix and even entirely off the subject before the meeting, the remedy lies in encouraging more people to talk rather than in persuading the willing talkers to "make it short." A few do all the talking only because the many will not talk.

INDEX TO VOLUME LXII

The index to Vol. LXII of Municipal and County Engineering, January to June, 1922, is now ready for distribution and

copies will be sent free on request to subscribers. All subscribers are urged to bind their copies since this can be done at trivial cost, and the bound volumes of this magazine are very valuable for reference purposes. Every issue contains much matter of permanent worth which should be preserved.

WALKING ON THE HIGHWAY

It is a common experience when driving on highways near large cities, especially on Sundays, to see hundreds of people walking on the paved roadway and every last one of them on the wrong side of the road. That is, with almost negligible exceptions, those who walk on the roadway walk with the traffic instead of against it. This frequently leads to accidents for which the motorist gets all the blame. The wonder is not that some are injured in this way, but that the number is so small. Very often pedestrians may be seen walking three or four abreast, forming a line that completely obstructs one traffic lane. They have their backs to the traffic on their side of the pavement and pay no attention whatever to signals to move over.

Whatever may be said of the rights of the pedestrians and of the motorists in such cases, one must marvel at the assurance of the pedestrian that the motorist not only must not, but will not run over him. Many pedestrians do move over, perhaps the majority do, and this leads the motorist to expect the pedestrian to give ground; therefore when an occasional pedestrian does not give ground he runs a grand chance of getting hurt or killed.

In walking on the highway a pedestrian should face traffic and keep to the edge of the roadway, quite as much to insure his safety as to conform to the old rule of the road. Pedestrians have always yielded ground to wheel traffic and this is the sensible as well as the proper thing to do.

MUNICIPAL BOND SALES

Municipal financing reached what will probably prove to be the peak for 1922 in the month of June when an aggregate par value of $154,273,633 permanent state and municipal bonds were successfully marketed. This brings the total for the year up to $713,070,097. Should the balance of the year see as much additional borrowing on the part of the states and their political subdivisions, the record total of 1921 will be exceeded.

ADVERTISING SIGNS ON THE HIGHWAYS

Although we have favored the regulation, or censorship, of highway advertising signs, rather than their absolute prohibition, the weight of opinion is clearly in favor of driving these signs off the highways entirely. Perhaps there will eventually be a reaction against this form of prohibition and the signs may be allowed to come back under proper regulation.

While we have no selfish interest in billboard advertising we dislike to see the boards lose out entirely. The newspapers started the fight and apparently have it won. Money that went into billboard advertising did not go into newspaper advertising and that caused the newspapers to wage their war of extermination on the boards. If the public interest in this matter really requires the removal of advertising signs there is nothing more to be said, but we cannot agree that this is the case. The advertising sign may be made an aid to the traveller, rather than a source of danger to him or a blemish on the face of nature; this result could be secured by regulations imposed by highway authorities.

In town, too, the billboards are losing out, and this despite their demonstrated worth. Who does not recall the use the Rotary Clubs made, not long ago, of billboard advertising in their campaign to improve business conditions? Many people read the boards who seldom read newspapers or magazines. Then, too, when one is on the move and catches the flash of a few words on a sign, he has time to think of their import before his mind receives another impression. Suppose some ethical culture society should start out, little by little, to improve the human breed. Could they find an adequate substitute for the billboard? It may be doubted. Suppose it was desired to direct attention to Prejudice, the force that arrests the political and social regeneration of the race. A billboard campaign directed against prejudice would do more to lift this blight from human life in 60 days, than all the books ever written have been able to do down to this hour.

So we rather dislike to see the boards go for, rightly used, they would throw flashes of light across "the dark night of man's mind."

EFFECT OF CORE DRILLING ON PAVEMENT PRICES

The editorial entitled: Effect of Core Drilling on Pavement Prices, published on pages 159 and 160 of the May, 1922, issue, has lead to considerable discussion of this timely topic. Discussion in this case as always is highly desirable as it is through discussion that knowledge advances and justice is established and maintained. The editorial has been well received by some readers but other readers are unable to agree with the thoughts it expressed. Inasmuch as this is a journal of honestly-held opinions no objection exists to the publication of views partially or entirely at variance with those held by the editor.

Although the editorial stated that core drills are being used by several state highway departments, and the discussion was intended for national rather than state application, the specific example cited pertained to Indiana practice and this fact not unnaturally led some to conclude that the Indiana State Highway Department had been singled out for criticism but this, of course, was not the intent of the editorial. This impression, however, has led to some very interesting and valuable comment in Indiana, typical examples of which are here reproduced for the information of our readers.

Mr. C. Gray, Chief Engineer of the Indiana State Highway Commission, gave out the following statement with reference to the editorial:

"An editorial in the May number of Municipal and County Engineering, entitled, 'Effect of Core Drilling on Pavement Prices,' takes exception to use of the core drilling machine for checking depth of pavement. The article attempts to show that it is unfair to contractors and will increase the cost of our pavements.

"The Indiana State Highway Commission is anxious to secure construction of highways at the lowest possible cost of each individual type, but not to the extent that we would have an understanding with contractors that a shortage of depth in the pavement would be permitted.

"The article states, that where a core drill is to be used, the specifications should make the fact clear. Our specifications do make such provisions, but I fail to see where such a clause is absolutely necessary, as our cross section shows the design of the pavements in detail, including the depth, and our form of contracts provides for the construction according to the plans and specifications. The writing of adequate specifications and the proper design of pavements means nothing unless the plans and specifications are carried out during construction. The article also states that if a thin slab means that the engineers and inspectors on the job are to be discharged, the contractors are in for a hot summer. This is exactly what it means on Indiana work—in addition to the fact that the contractor will not receive payment for deficient pavements.

"We require from 75 to 100 engineers and inspectors on our construction work during the construction season, and in order to secure technically trained men with practical experience, it is necessary to hire men from all parts of the country, about whose honesty we know nothing more than that given by their references. One can readily see that there is a possibility of securing those who would be susceptible to offers of compensation from contractors. There is also the possibility of contractors intimidating the inspector. We have a clause in our specifications which states that on completion of the work, the chief engineer shall make a final inspection of the work before final payment is made. The coring of the pavement is a part of this final inspection and is a protection to the State against dishonest contractors and inspectors.

"The core machine protects the taxpayer, the honest inspector and the honest contractor. With a definite check on the work, the honest contractor does not have to compete with contractors who bid low with the expectation of 'getting by.'

"Mention is made of the fact that if the engineer is liberal in his interpretation of the specifications, the contractor will not be greatly worried by the core test. Taxpayers have invested thousands of dollars in 'liberal interpretations of specifications' in past years, and it is due time that they insisted that all of the money be placed in mileage of roads.

"I am of the opinion, that the Department, with the opportunity of observing the construction of hundreds of miles of roads under different conditions, and where many different methods of construction are used, is in as good a position to judge as to what degree of accuracy it is possible and practical to work, as is the average contractor."

Honesty in Road Building

The *Evansville* (Ind.) *Journal* for June

30, 1922, ran an editorial entitled: Honesty in Road Building, which quoted the major portion of Mr. Gray's statement and added the following original paragraphs:

"When representative periodicals devoted to public improvement, and reflecting in part the opinion and sentiment of contractors, protest against absolute quality tests by the Indiana Highway Commission on road surfacing and foundations, it's curiously interesting to the taxpayer. The theory of one such protest, appearing in Municipal and County Engineering, published at Indianapolis, is that core drilling to test road foundations is both unfair to the contractor and will increase the cost of paving. To such a contention C. Gray, Chief Engineer of the Highway Commission, presents a sufficient and convincing answer.

"Mr. Gray says, with a touch of irony, that 'taxpayers have invested thousands of dollars in past years in liberal interpretations of specifications.' Anything that will insure a dollar's worth of material and labor for a dollar's worth of pay on road work will be received with profound and solemn satisfaction by the people. Any road that isn't built according to specifications contains less than the people are paying for.

"Every road contractor is entitled to his fair profit on every foot of work that he does. But the State of Indiana, far from being criticized, is to be commended for devising a method that will reveal whether roads are up to standard. Any insinuation from a supposedly authoritative spokesman of the contractors that the continuation of core drilling will mean higher prices in future comes in shockingly poor grace. It is tantamount to an admission that some contractors have been scamping their work. And it's precisely that condition that the core drill is meant to reveal aud prevent."

The Indianapolis News, for July 1, 1922, ran an editorial entitled: The Road Core Question, as follows:

"The plunging of a corer into what has every appearance of being a perfectly good watermelon, often seems like a ruthless and damaging proceeding, and yet it adds greatly to the confidence of the purchaser that he is getting his money's worth. The same line of thought applies to the question of the use of a coring machine by the State Highway Department on roadways to determine whether they have been constructed according to specifications. A trade magazine devoted to construction work seems to have been shocked at the thought of the cruel corer's plunge into a pretty pavement, and to have discussed this in an editorial on 'The Effect of Core Drilling on Pavement Prices.' No doubt a strong case could be made showing that coring of watermelons tends to raise the price, but the wise buyer would rather pay the higher price than run the risk of taking the untested melon.

"The general public, therefore, which is the real purchaser of pavements, will be likely to take comfort in the attitude of C. Gray, Chief Engineer of Construction of the State Highway Department, who appears to believe that a pavement should show itself to be really ripe before it is paid for. In reply to the trade publication comments he says:

> The writing of adequate specifications and the proper design of pavements, means nothing unless the plans and specifications are carried out during construction. The editorial says that contractors are in for a hot summer if concrete pavement not exactly up to specifications means that engineers and inspectors on the job are to be discharged. This is exactly what the Indiana Highway Department means to do, and in addition, the contractor will not receive payment for deficient pavements.

"The use of the coring machine is to check up on previous work of the department's inspectors. Mr. Gray calls attention to the fact that from 70 to 100 engineers and inspectors are required on construction work in the busy season. In order to obtain technically trained men with practical experience it is necessary to engage men from all parts of the country, about whose honesty the department may know nothing more than is given in their references. Some may be susceptible to offers from contractors, and some may be of the kind that can be intimidated by contractors. Says Mr. Gray:

> The core machine protects the taxpayer, the honest inspector, and the honest contractor. With a definite check on the work, the honest contractor does not have to compete with contractors who bid low on projects with the expectation of getting by with dishonest work.

"This sounds like good sense. The spirit of Mr. Gray's remarks is of a kind that tends to be heartening to those who hope for roads good all the way down. For the solid satisfaction of such roads

taxpayers should be as ready to pay as the melon consumer is willing to give something more for fruit good right up to the rind than for melons of uncertain quality."

Our editorial on the subject is on record and easily obtainable by any interested person so there is no occasion for reproducing it here. Our discussion turned on the point that the core test "may be fine in theory but not so good in practice." We also stated, and still maintain, that: "The engineer who intends to use the core test before paying for a pavement should make that fact very clear in his specifications. The contractor should be warned in advance of this new hazard in his already very difficult and hazardous calling. The method of making the tests should be made known to the contractor before he starts to build and he should also be told just what interpretation will be placed on the test data and how these interpretations will affect the payments due him." In other words, if a depth of 6 ins. is specified is that to be regarded as the minimum depth, or as the average depth with a variation of ½ or ¼ in. below the specified depth permitted? Again, if a penalty is to be imposed for a deficiency in thickness what about a bonus for an excess? We believe that since a pavement cannot be constructed, under field conditions, with the same precision as a test specimen in the laboratory, that it is no more than fair to tell the contractor just what variation from standard will be permitted. We do not believe that fairness to the public, in whose service we have produced this magazine for 32 years, requires that the contractor who bids on a 6 in. pavement should be scared into building a 7 in. pavement. Perhaps that contingency will not arise; we hope not, for eventually inequities react against the public. The use of the core test is not necessarily unfair but it may be unfair—we argue merely for fairness in its use realizing from construction experience the great difficulty of an absolutely exact compliance with any set of specifications, no matter how pure the motives of the contractor may be.

With reference to the effect of the test on pavement prices we note with lively sympathy what *The Indianapolis News* says about "plugging" watermelons. Never was comparison more apt. We are also of the opinion that it is better policy to pay more for a plugged melon of demonstrated quality than to take a chance on acquiring unripe fruit. If the public is willing to pay more for a "cored" pavement than for an "uncored" one, as the *News* advises, we have no objection but would be the first to applaud such a sensible policy. What we would oppose, in the name of the entire construction industry, is furnishing any "cored" commodity to the public, whether melon or pavement, at "uncored" prices. And right there we rest our case.

ECONOMIC ASPECTS OF TOURIST CAMPS

To the Editor:

While your editorial on "Tourist Camps," which appeared in the June issue, contains no misstatements, it tends to leave with the reader several impressions which, viewed in the light of an extended investigation of this subject which I have been carrying on for several months, seem to me to be erroneous.

The viewpoints of the hotel man and the taxpayer are certainly entitled to consideration—but just what are these viewpoints?

In the development of tourist camps it has not been unusual to encounter apprehension on the part of hotel-keepers as to a possible loss of trade due to the existence locally of well-developed tourist camps, but in certain specific instances, at least, this feeling has disappeared after the local camps have been in operation for a short time.

The general tendency of tourist camps is to encounter tourist travel by automobile. The hotel man profits by this increased tourist travel, as a portion of the increase results in at least occasional hotel patronage.

In the case of small towns, it is seldom that the local hotels are of a character that cause the town to be seriously considered by tourists as an overnight stopping place. It is usually easy to push on to a larger place offering better hotel accommodations. Any town, however, can afford to establish an attractive camp and maintain it properly, with the result that many tourists will stop for the night rather than drive on to the next camp.

While in most tourist camps there may be found touring parties that could readily afford to patronize the best hotels, it should be kept in mind that to the greater portion of auto tourists it is the economy of the camping plan that makes possible to them the many advantages of travel. These visitors do not, therefore, represent a loss of custom to the local hotels.

The viewpoint of the taxpayer is cer-

tainly a variable quantity. There are "knockers" and "wet-blankets" in every community (they serve a useful purpose in providing obstacles for the "boosters" to overcome), and there are also many enthusiasts on tourist camps. All of these are taxpayers.

Properly located and maintained, a tourist camp need not interfere in any way with the routine of the individuals of a community. The cost to the taxpayer, moreover, need not be appreciable. Usually the municipality confines itself to furnishing the site (frequently a portion of a city park) with free light and water—properly leaving to the commercial men (often assisted by civic organizations) the development and maintenance of the camp facilities.

Careful investigations in certain western districts and cities have shown that in the average city the tourist camps easily pay their way ten to one in profits on local sales. Over 1,200 cars visited a certain western camp last August. Of these over 1,000 drivers filled out questionnaires which indicate that the local purchases of the average tourist party amounted to nearly five dollars per person. These purchases accrue to the benefit of many classes of merchants and, as they derive the financial benefit, it is only fair that they should assume most of the burden. Some of the most elaborate western camps are owned outright by commercial organizations.

Your conservatism in advising communities to go slow in developing tourist camps is hardly necessary in the case of the average town. What they usually need is encouragement of a more aggressive sort.

This is the situation. In most western and middle western states some sort of camping site is available within a few hours' drive from any point. Wide-awake commercial and civic organizations realize the value of the trade and the free advertising of the tourists, and are securing the good will of each transient by extending to him a hearty welcome and such service as he needs—finally sending him on his way a perpetual "booster" for such communities.

This means that a growing competition exists among communities in the matter of providing attractive accommodations. The town that is content simply to set aside a tract of ground and to erect a few signs welcoming the auto traveler will be "passed up" by a lot of traffic that might readily be encouraged to stop. Auto parties will often stop hours before dark where they notice the facilities of an attractive roadside camp. Unless a community is unusual as to location, isolation or points of interest, a conservative policy as to tourist-camp development can but result in losing most of its fair share of tourist patronage.

In constantly increasing numbers tourists are "taking to the road" in order to have the freedom thus gained as to route and schedule. The average auto tourist travels leisurely, frequently remaining for several days—or even weeks—in towns that offer him real hospitality and real service.

The tourist camp is a definite expression of the hospitality of the west, modified to meet the needs of the modern visitor who has selected the highway as the best way to see and to know the beauty spots of his country. It is a wonderful opportunity for service and good fellowship on the part of any community. It has proven to be a good business proposition, entirely aside from the advertisement of the community which thus gains new friends, new business and, frequently, new citizens.

In business and in advertising the aggressive policy, other things being equal, is the winning plan. So it is, as I see it, in the case of the development of tourist camps.

Very truly yours,
ROLLAND S. WALLIS,
Municipal Engineer,
Engineering Extension Department, Iowa State College, Ames, Iowa, June 30, 1922.

STANDARD FORM OF PUBLIC WORKS CONTRACT ADOPTED BY TEXAS SECTION AM. SOC. C. E.

By John B. Hawley, Consulting Engineer, 403 Cotton Exchange Building, Fort Worth Texas

(Editor's Note: Mr. Hawley was chairman of the Contract Committee that prepared the standard form of contract discussed in the present article.)

The usual contract between a City, County, or other political subdivision of a State, and the contractor who undertakes construction of public works is, and for generations has been, an instrument setting forth what the contractor must do, and what the other party may do. (You could almost put it "*may do to him.*"

The very word "contract" implies from

its Latin derivation that each party shall bring something, in equal shares, to the consummation of the undertaking. Mutuality of interest and responsibility, in the very nature of things human, are "of the essence" of the situation, a condition quite generally lost sight of.

Most public works contracts are so lacking in "mutuality," so "unilateral," "lop-sided," if you please, that the courts, when the issues are tried before them, brush the documents aside, (except for the mere matter of listed prices) and proceed to hear and determine the cause upon its merits.

The learned counsel who formulates the usual public works contract must have read Kipling's "Introduction" to "Regimental Ditties and Barrackroom Ballads," especially the stanza:

"Who shall doubt the secret hid
Under Cheops' pyramid,
Is that the Contractor did
Cheops out of several millions."

And with this as his inspiration drafts what more nearly resembles a Draconian code than an agreement to do and to pay.

Of late years engineers and lawyers who specialize in public works matters have become aware of the necessity for a form of contract that would provide something like mutuality. The attitude of courts, above referred to, has been somewhat an impelling cause.

National organizations have undertaken studies through standing committees and even sections of several societies have endeavored to improve conditions.

Among the latter, the Texas Section of the American Society of Civil Engineers has for several years worked upon a standard form of contract.

The Texas committee was composed of two engineers exclusively in the practice of engineering; two exclusively in contracting, and the chairman an engineer who for more than thirty years has actively practiced engineering with his time pretty evenly divided between service for municipal corporations and high-grade contractors.

The first draft, a form very closely following the one used by Mr. Daniel W. Mead in his private practice, was studied by each committeeman, who annotated it and sent it to the chairman. The several comments were noted on another draft and this remodeled form again submitted to all committeemen. This process was repeated several times until the committee were agreed upon a draft which was multigraphed and mailed to every member of the Society in Texas.

Comments and suggestions were sent in to the chairman by something like half the membership, and these collated and prepared for discussion by the committee. The committee met several times in various Texas cities, altered the form from time to time, but finally, in October, 1921, unanimously agreed to report a finished document to the annual convention of the Texas Section, held in Dallas.

The convention, on Oct. 28, 1921, unanimously adopted the form of contract as submitted by the committee and ordered 3,000 copies printed, to be furnished members and the public generally, at cost, which is 15 cts. per copy.

The committee drafted a foreword or preamble which accompanies each copy. It reads as follows:

"This Standard Contract Form was unanimously recommended by the Committee on 'Standard Form' and unanimously adopted by the Texas Section, American Society of Civil Engineers, at the Fall Meeting, Dallas, Texas, Oct. 28, 1921.

"The 'form' is the result of several years' research by individual members of the committee,and of their joint work in many meetings since October, 1920.

"Neither the Committee nor the Section believes the Contract to be the sole form suitable for every public works project, and it is not intended that it shall be forced upon the profession.

"It is, however, believed that the Contract is the best yet formulated for the administration of public works in Texas; that it is comprehensive, orderly and equitable in terms, and that its general adoption by members of the profession will result in saving millions of dollars annually to both OWNER and CONTRACTOR, by the elimination of hazards contingent upon less equitable contract forms."

As may be imagined, the arbitration clause was the subject of most prolonged discussion and most earnest debate by the committee and membership at large. Engineers have so long been accustomed to considering their rulings on any point as "final and binding" on both parties to a contract, that any proposal to limit their powers, even by so obviously fair and equitable a means as arbitration, at first blush seemed an affront, as one "old-timer" expressed it, "contempt of court." Like all other provisions of the committee's form, however, the arbitration clause was unanimously adopted.

(In Texas and many other states a city may not lawfully sign away its rights to its "day in court." Consequently the arbitration clause has the following provjso: "The decision of the arbiters upon any question submitted to arbitration under this contract shall be a condition precedent to any right of legal action. The decision of the arbiters may be filed in court to carry it into effect.")

The eminent lawyers, specialists in public works contracts, employed by the committee, favorably passed upon the arbitration clause as, in fact, they passed upon the complete form.

The arbitration clause is doubtless the most important feature of the document.

Only those who have had long and intimate contact with the contractor's side of public works life are aware of the apprehension, trepidation, suspicion, if you please, with which an experienced, prudent contractor formulates his proposal for the construction of a good-sized piece of public works, the direction of which is to be in the hands of an engineer whose reputation for fairness is either unestablished or dubious.

This apprehension manifests itself in very substantial, material form as a percentage, included in each unit bid, to cover "the hazard of the engineer."

The arbitration clause will eliminate the fear of unjust rulings by the engineer, and by the same token, the percentage added to cover that "hazard." One of the most experienced (and respected) engineers in the South estimates that the Texas standard contract form will save at least five per cent on the cost of all public works.

In Texas alone this would mean $5,000,000 annually saved the public.

It is to be hoped that other state sections of the great societies and finally the parent bodies will follow the way marked out by Texas and adopt standard contract forms that will equally protect the rights of "both parties hereto."

It is not practicable, because of space limitations, to reproduce the contract form in full in this article. However, the scope of the document is well indicated by the following headings listed on the index page.

Bond; general conditions of the agreement; notice to bidders; preface: proposal; standard form of agreement; abandonment by contractor; abandonment by owner; arbitration; assignment and subletting; bond; changes and alterations; character of workmen; collateral contracts; contractor; contractor's agent; contractor's buildings; contractor's duty: construction plant; damages; defects and their remedies; delayed payments; discrepancies and omissions; engineer; engineer's authority and duty; estimated quantities; exhibits; extension of time; extra work; final acceptance; final payment; hindrances and delays; interpretation of phrases; liquidated damages for delay; lines and grades; losses from natural causes; owner; partial payments; penalty and bonus; plans and specifications—keeping accessible; preliminary approval; price for work; protection against accident to employes and public: protection against claims for labor and material; protection against royalties or patented inventions; protection of adjoining property; quantities and measurements; right of entry; right of engineer to modify methods and equipment; sanitation; superintendence and inspection; time of filing claims; time and order of completion.

The arbitration clause, the most important feature of the contract, follows in full:

Arbitration

"All questions of dispute under this Agreement shall be submitted to arbitration at the request of either party to the dispute. The parties may agree upon one arbiter, otherwise, there shall be three; one named in writing by each party, and the third chosen by the two arbiters so selected; or if the arbiters fail to select a third within ten days, he shall be chosen by..... Should the party demanding arbitration fail to name an arbiter within ten days of the demand, his right to arbitrate shall lapse, and the decision of the ENGINEER shall be final and binding on him. Should the other party fail to choose an arbiter within ten days, the ENGINEER shall appoint such arbiter. Should either party refuse or neglect to supply the arbiters with any papers or information demanded in writing, the arbiters are empowered by both parties to take ex parte proceedings.

"The arbiters shall act with promptness. The decision of any two shall be binding on both parties to the contract. *The decision of the arbiters upon any question submitted to arbitration under this contract shall be a condition precedent to any right of legal action.* The decision of the arbiter or arbiters may be filed in court to carry it into effect.

"The arbiters, if they deem the case demands it, are authorized to award the party whose contention is sustained, such sums as they deem proper for the time,

expense and trouble incident to the appeal, and, if the appeal was taken without reasonable cause, they may award damages for any delay occasioned thereby. The arbiters shall fix their own compensation, unless otherwise provided by agreement, and shall assess the cost and charges of the arbitration upon either or both parties. The award of the arbiters must be made in writing, and shall not be open to objection on account of the form of proceedings or award."

QUANTITY SURVEY SERVICE IN THE PUBLIC WORKS FIELD

By William E. Skinner, The Associated Engineers, Inc., Engineers, Constructors, Managers, 86 Michigan St., Milwaukee, Wis.

The Quantity Survey System has been advocated since 1891 by Mr. C. Alexander Wright, A. I. A. of San Francisco, who is the founder of the movement to adapt the Quantity Survey System to American building practice. It has attracted much attention among contractors, architects and engineers, and in the course of time this system of estimating must be adopted as it stands for a square deal between the owner and the contractor.

The quantity survey system has been in use in Europe and particularly in England, France and Germany for many years, and it has also been used in the United States to a limited extent on some classes of work for a considerable period of years, but it is only within the last three years that there has been a quantity survey bureau in this country which was prepared to handle the various classes of this work, as was offered to it.

The railroads have for years required a detailed bill of material on their construction projects, and the highway work of the country is let on a basis of so much per cubic yard for excavation, so much per square yard for surfacing, and the amounts of excavation and surfacing in nearly all cases are calculated and stated so that the bidders on these classes of work have had the benefit of a virtual quantity survey.

The Quantity Survey Defined

The quantity survey is a bill of material taken from the plans and specifications, but is not, as many people have supposed, merely the taking off of a list of items by one person, probably with uncertain accuracy, for some other person's use. It means the careful measurement by a disinterested expert who proceeds in a manner quite different from that of the average contractor. He uses some recognized order and system in taking off the quantities, abstracting and billing, with a view to the elimination of errors, and he expresses these quantities in certain uniform standards of measurement, and expressions well understood by the bidders; and his checking and rechecking methods, to insure accuracy, must be studied to be appreciated by those to whom the quantity system is unknown.

Such a quantity surveyor, in taking off quantities from an architect's or engineer's drawings, readily detects any discrepancies due to hasty preparation or other cause. By means of this co-operation the attention of the architect or engineer is called to such matters by the quantity surveyor as he goes on with his work, thereby eliminating uncertainties in the plans and specifications.

The result of the quantity survey is then blue-printed, mimeographed, or otherwise reproduced, and a copy supplied to each bidder, who has only to insert his prices opposite the items and put up the totals. To quote Kidder, "This is really all that contractors should be expected to do (for nothing)."

Many people are under the misapprehension that the contractor makes his estimates on the various jobs for nothing; that is to say, that the owner does not pay the contractor for making those estimates in the course of preparation for their bids; but the modern contractor includes in his overhead, which he charges against the job that he gets, not only the cost of estimating that particular job, but also the cost of estimating the jobs that he did not get. From the foregoing it can be readily seen that the method, while painless to the owner, is yet withal both costly and wasteful, and occasions a large amount of duplication of effort on the part of the various contractors.

15 Advantages Claimed for Quantity Survey System

The advantages claimed for the quantity survey system are so well set forth by Kidder's Architects' and Builders' Handbook (17th Edition), which is in use in the majority of the architects' offices as a reference book, that I do not believe I can do better than to quote the following 15 advantages claimed for the system:

(1) An immense saving of time and

money now wasted by bidders; all doing the same thing, going over the same ground, and each arriving at a different result.

(2- Safer bids, as the work to be performed is clearly written out in the bill of quantities, which can be the essence of the contract.

(3) No expense to the bidder; the owner pays for the quantities knowingly. The owners pay now, but this fact is not brought to their attention, and it does not occur to them. The percentage added to a bidder's net cost is not all profit, a certain portion being absorbed in overhead charges, including cost of estimating which, of course, is ultimately borne by owners.

(4) Savings of disputes arising from ambiguities, oversights, and even errors, all causing extra claims more or less just, but usually vexatious, and sometimes embarrassing.

(5) Better opportunities for the competent bidder, as the bidders all work up and price from the same basis.

(6) Better work and greater harmony. If no part of the work is omitted there is less reason to skin the work, a proceeding which produces friction, or worse.

(7) Misunderstandings are reduced. The bill of quantities states clearly what is intended, and is a sort of clearing-house for the drawings and specifications.

(8) Neither party can obtain an advantage over the other on quantity or description of work.

(9) No disputes with sub-bidders, it being clearly stated what each trade is to furnish.

(10) Contractors have no figuring of quantities to do and can therefore devote more time to buildings in hand and save profits now lost for want of their personal supervision.

(11) Fewer inferior contractors as lowest bidders.

(12) Fewer extras, which are usually a trouble to all concerned.

(13) The architect or engineer has the assistance by collaboration of the professional quantity surveyor, who is available, also, for preliminary figures. This advance information, now so often furnished by a prospective bidder, creates undesirable obligations.

(14) No change or reorganizing of architects' office is entailed. Much detail work now involved in receiving bids could be taken care of in the quantity surveyor's office.

(15) The drawings and specifications having been previously made as complete as possible, subsequent inconvenience to contractors and foremen on the job, and inquiries at the architects' offices for explanations become unnecessary. The *Bill of Quantities* gives detailed information which cannot be well given by drawings.

Value of Quantity Survey Illustrated on Manitowoc, Wis.

By reason of the foregoing advantages one can easily see that there should be some financial benefit derived by the public in using a quantity survey of public work. Only recently the School Board of the City of Manitowoc, Wis., took bids on a proposed high school for the city, and a study of the bids submitted shows the following interesting result:

The two lowest bidders had the advantage of a special check on the general contract items prepared by the firm, with which the writer is connected, and their bids were, in round figures, $379,000 and $384,000, while the next two bidders above did not take advantage of any such check, and their bids were $417,000 and $442,000, leaving a difference of approximately $35,000 or about 9%, between the bidders who had a check and were, therefore, able to figure more closely than the bidders who did not take advantage of such a check on their estimates. The average fee charged for making a quantity survey is based on one-half of 1% of the cost of the project, which, in this instance, would have amounted to only about $2,000.

From the examination of a considerable number of jobs where quantity surveys have been prepared on the general contract at the specific request of some bidder, the above results have been so uniformly the case that there is no question in my mind but that the quantity survey was responsible for the major part of that saving.

When the quantity survey is used on a job it should be guaranteed by the owner, and even in event of the quantity surveyor having made an error in his figures there is no damage done, since the bids are based on the amounts of material shown and the result in such a case would be merely the adding or subtracting of an amount of material at the rates given in the bid.

The Building Council of New York City has a special committee which at the present time is making a thorough study of the quantity survey work as handled by the different quantity survey bureaus

throughout the country, with a view to establishing uniform service. This committee has, so far, learned of the existence of quantity survey bureaus in Boston, New York, Baltimore, Chicago and Milwaukee, and it is probable that there is also a bureau at Minneapolis.

The efforts of the quantity survey bureaus of this country to have the quantity survey furnished to go with the plans and specifications, as furnished by the owner to the bidders, is gradually meeting with success, and it is fair to assume that not many years will pass until this practice becomes universal in this country, as a result of the demands made upon the construction industry to eliminate waste and proceed in the most economical manner.

THE ENGINEERING EXPERT WITNESS AND TECHNICAL ADVISER

By Paul E. Green, Consulting Engineer, 1002 Wrigley Bldg., Chicago, Ill.

In the vast development of our modern city a wide field has evolved in which the expert technical witness and consultant is in active demand. Many of our states require that certain classes of municipal work, particularly those in which the cost is assessed against property benefited, should have court hearings before the assessment is finally legalized. At these court hearings, if it is shown that the work has been improperly or extravagently designed or constructed, it may occur that the proceedings are annulled because the improvement becomes an unreasonable one. It frequently happens therefore, that the assessment is attacked by protesting property owners, and along these lines it is necessary for the city to establish, by competent expert engineering testimony, that the design is reasonable and good and that the construction has complied with the specifications.

Many cities having competent city engineers, find that because of his closeness to the public and to the city officials, the engineer does not always receive the confidence which he deserves. The consulting engineer and expert therefore is frequently called in to advise in the design of these various improvements and in addition may be called in to defend the design in court, or to advise the City Engineer and the Attorney as to drawing of the correct legal documents which cover the engineering phases of the work.

The benefits to be derived by the client from such work, provided the choice of the consulting engineer has been a happy one, are large. The city goes ahead more confidently with the improvement because its design has been carefully checked by a disinterested expert, the attorney is more fully advised as to the technical details, the city engineer draws his plans more carefully because he knows that they are being checked and supervised by another engineer, and the public being informed that the city has retained a consulting engineer has the feeling that its interests are more fully protected than they might otherwise be. This condition applies not only to the smaller cities but to the largest ones, also. Many of the city engineers of the smaller towns have graduated from the ranks of the surveyors. They are often first class mathematicians and their experience is broad as to amount of work which they have done in that particular locality, but limited as to the whole field.

After a scheme has once been adopted the consulting engineer is particularly valuable in court trials, not only as an expert witness but as a technical adviser to the attorney. This is a broad field for consulting engineers but not all consulting engineers, no matter how able, are suitable for this class of work. Some of the most able engineers with whom the writer has been acquainted have made the poorest witnesses and advisors in trials of this character. The reason is, not that they have not the knowledge but that they have not the ability to impart this knowledge to the court, jury, or to the attorney, do not make positive statements, or assume an intolerant attitude.

For the expert witness there are many dangers to be avoided. He must not be too technical, otherwise his testimony is likely to be ignored as being a purely theoretical statement not backed by practical experience. In addition an extremely technical witness tires both court and jury. Sufficient technical knowledge and experience should be shown to qualify thoroughly but finely drawn deductions should be avoided.

Another fault of many technical advisers is that many engineering experts tend to lean backward in their testimony. Their thought seems to be that they must be judicial and very conservative in their statements, even to the extent of accepting some part of an adverse conclusion (which may have been considered and rejected because of their own judgment of the matter) in order to show their

fairness. It should be borne in mind that the technical expert, while he is expected to be correct and fair in his statements, is employed to defend a particular scheme and design and that he should assemble the valuable points for his client and combat unfavorable ones. It is rare that there are not two sides to a case and that alternative designs may not be introduced that are very nearly as meritorious as the one which he is supposed to advocate. But the witness that is not positive in his statements and sure of his ground is an actual detriment to the side which he represents. An expert should be an impartial judge in originating and advising as to the design and in deciding between two or more designs. But one having made a decision based on his best knowledge and ability he should defend it vigorously. He should not exaggerate but he should also not under rate the merits of his scheme.

It seems to the writer a not unimportant point is that it is essential for a high class professional witness to present a good appearance in a court case. This means that he should be well dressed, that he should not be the rough and ready type and that it is essential that his testimony should be scholarly and polished as well as practical. Such a combination adds to the value of the witness for primarily the engineer in such cases is there as an advocate of his client's interests in the same manner as is the attorney. On the stand he should not argue with his attorney or the opposing attorney and above all things before he accepts a commission to act in this capacity he must believe in his own case. A smooth speaking, pleasant, technical witness who does not get excited, angry or make exaggerated statements is almost unbeatable.

When an engineer is retained to assist an attorney in a technical case he should not confine his work to the court room alone, otherwise he will probably find that his testimony and advice is worse than useless. In other words he must be adequately prepared. Probably in most cases the bulk of the work which he will do will be outside of the court room. He must make a close study of the law which covers the improvement so that if other and opposing technical witnesses are examined he may be able to assist the attorney in pointing out weak spots in their testimony. He should make a thorough study of the location of the improvement and a minute detailed study of the design even if he has had nothing to do with it in its original form. Not only should he make the study of this design, but he should carefully examine alternatives so that he may be able to forestall objections to the design which is being examined in court, and to bring out the strong points of his own case. He must very fully advise the trial attorney on these matters, in fact he should come pretty near educating the attorney or attorneys along the technical lines which are required in the particular case. From his client he must insist on complete data or that he be given sufficient time to accumulate the data. Nothing is more fatal than to go into a case of this kind without complete information. It may be taken for granted that the other side will supply it to him in the shape of unfriendly witnesses if he does not have it.

Frequently diagrams and drawings are needed, both for the information of the court and for the jury in case it is a jury trial. These diagrams should be made to a large scale and the mooted points shown in strong colors. Several copies of each of such diagrams should be available not only for the court but for the opposing attorneys, engineers, and for his own witnesses. In an important case the engineer should insist that the testimony be written up each day and this testimony he must very carefully and thoroughly study. If the testimony of the opposing technical witnesses is complicated he should request his attorney to defer cross examination for the time being until such testimony can be read and studied, otherwise he is almost certain to overlook important points.

Finally after the testimony of both sides is in the time for argument arrives. At this time the engineer should be particularly valuable to his client. If he has properly studied the case he has tabulated all the important points and discussed them with his attorney. The writer has found it to be a valuable and helpful practice to argue and present the case, as it appears to him, to his attorney in the same manner that the attorney will later argue to the court. In this way the trained legal intellect of the attorney is pitted against his own engineer for the purpose of strengthening the case. Valuable points are brought out and the attorney is able to see the case more clearly because of the argument than he otherwise would and thus more clearly to present it to the court and jury in his own statement.

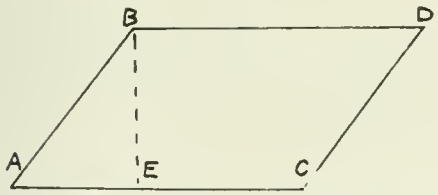
A MODIFICATION OF THE VICARI METHOD OF DETERMINING MAXIMUM RUNOFF

By Kenneth Allen, Sanitary Engineer, Board of Estimate and Apportionment, Municipal Bldg., New York, N. Y.

The usual procedure in determining runoff to sewers by the rational method is often tedious, especially where maximum volumes occur from storms of shorter duration than the period of collection.

In Engineering News, Nov. 5, 1914, Mr. O. Hufeland described a graphic solution of the problem which it is understood originated with Vicari at Milan and was later expounded by various German authorities. A full description of the method may be found in Hutte's Handbook and a synopsis is given in an article by Wynne-Roberts and Brockmann in The Surveyor and Municipal and County Engineer of April 18, 1913, so that any detailed analysis is unnecessary here.

In brief, however, a diagram is constructed by superimposing a series of rhomboids, each of which corresponds to a drainage sub-district. Each rhomboid is constructed by laying off:



A E=time of collection in minutes.

B E=rate of runoff in cu. ft. per sec. when the entire area is contributing.

A C=B D=duration of downpour.

With these superimposed rhomboids so located that any ordinate represents the same time in each—that is, so that the rhomboids for all sub-districts whose flow is combined at one point have the same abscissa—the maximum flow in the sewer will correspond to the maximum ordinate intercepted by the series of rhomboids.

The weak point in this solution lies in the uncertainty as to what duration of downpour to assume. Vicari seems to leave this to the arbitrary selection of the computer. An improvement would seem to lie in using the period of collection. Probably a yet better plan would be that suggested by R. D. Goodrich in a discussion of Mr. Hufeland's article (Eng. News-Record, Dec. 31, 1914), namely: After combining the intercepts on each ordinate so as to smooth out the jagged line formed by the sloping edges at the left of the figure (which rectified line will then represent the increment of discharge at the selected point during the first part of the downpour) lines parallel to this rectified line are drawn at intervals representing, say, five minutes to the right of the first. These lines then represent the diminution of runoff at the ends of these 5-minute intervals, the duration of downpour being measured by the horizontal distance between each rectified line and the first one. The ordinate intercepted between any rectified line and the first one which shows the maximum volume of runoff indicates by its abscissa the time when such maximum occurs, and the part of the abscissa intercepted by the two rectified lines represents the duration of downpour causing this maximum rate.

This duration may or may not be equal to the time of collection, depending on the shape and slope of the watershed area, but it is never greater. Likewise, the runoff can be found by measuring the ordinate intercepted between the two rectified lines for any part of the sewer system and for any time after the first of the downpour without the further construction of diagrams or computation.

The diagram shows the probable maximum runoff from the West 98th street drainage area in Manhattan. The runoff coefficient is assumed, for purposes of discussion, as 100 per cent, and the rainfall intensities those corresponding to the formula given below.

The jagged line on the left, shown rectified in the heavier line, indicates the beginning of the storm or downpour. The parallel rectified line indicating the end of a 4-minute storm is shown to the right, and the maximum ordinate intercepted between the two represents the maximum runoff with a storm of this duration.

The diagram, which was first plotted by Mr. Hufeland, was based on the observed fact that in a certain storm an intensity of 4.8 ins. per hour was maintained for four minutes and a scale of ordinates of 20 cu. ft. runoff per second to the inch was adopted. Applying the intensity formula $I=\frac{150}{t+16}$ (recommended in 1913 by the Committee on Rainfall and Runoff of the Municipal Engineers of the City of New York to the diagram, by which a rate of 7.4 ins. per hour may be expected once in 10 years, each inch represents $\frac{7.4}{4.8}$ x20=30.9 cu. ft. per second,

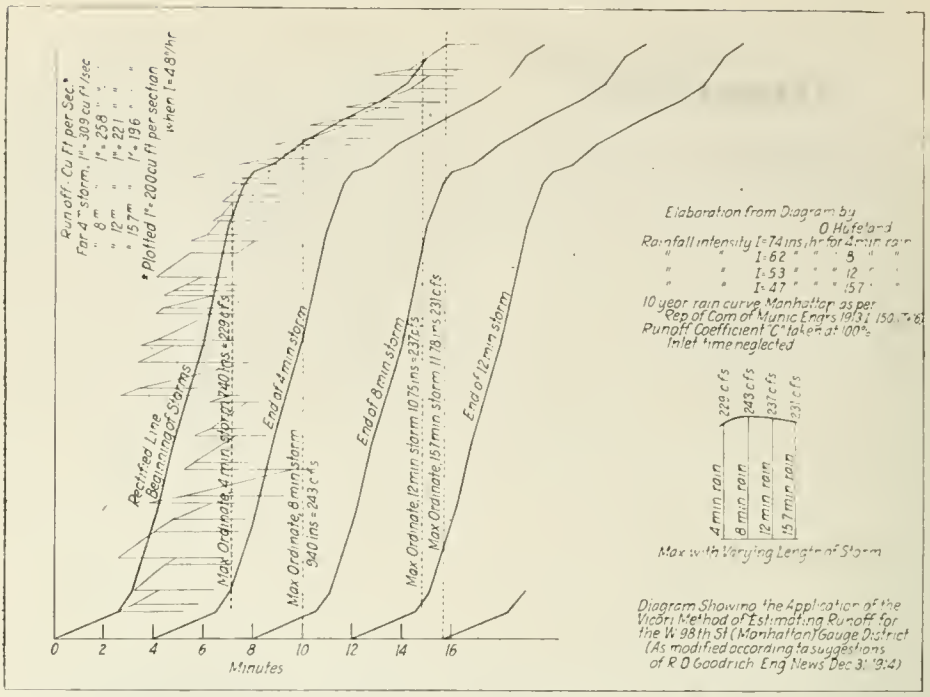

Run off, Cu Ft per Sec.
For 4" storm, I"=309 cu ft/sec
8" " I"=236 " " "
12" " I"=221 " " "
15.7" " I"=196 " " "
* Plotted I"=200 cu ft per section
when I=6.9"/hr
Rectified Line Beginning Storms
End of 4 min storm
End of 8 min storm
End of 12 min storm
Max Ordinate, 4 min storm 7.40 ins = 229 c.f.s.
Max Ordinate, 8 min storm 9.40 ins = 243 c.f.s.
Max Ordinate, 12 min storm 10.75 ins = 237 c.f.s.
Max Ordinate, 15.7 min storm 11.78 ins 231 c.f.s.
0 2 4 6 8 10 12 14 16
Minutes
Elaboration from Diagram by
O Hufeland
Rainfall intensity I=74 ins./hr for 4 min rain
" " I=62 " " 8 " "
" " I=53 " " 12 " "
" " I=47 " " 15.7 " "
10 year rain curve Manhattan as per
Rep of Com of Munic Engrs 1931 150.7=6.2
Runoff Coefficient "C" taken at 100%
Inlet time neglected
229 c.f.s
243 c.f.s
237 c.f.s
231 c.f.s
4 min rain
8 min rain
12 min rain
15.7 min rain
Max with Varying Length of Storm
Diagram Showing the Application of the
Vicari Method of Estimating Runoff for
the W. 98th St (Manhattan) Gauge District
(As modified according to suggestions
of R. O Goodrich Eng News Dec 31 '31:4)

DIAGRAM SHOWING APPLICATION OF MODIFIED VICARI METHOD OF ESTIMATING RUNOFF FOR W. 98th ST., MANHATTAN GAUGE DISTRICT.

and the measured intercept represents 7.40x30.9=229 cu. ft. per second runoff.

Repeating this with the rectified line for an 8-minute storm the maximum intercept is found to be 9.40 ins.; and as the intensity formula gives a value of I=6.2 ins. per hour, the intercept corresponds to $\left(\frac{6.2}{4.8}x20=25.8\right) \times 9.40=243$ cu. ft. per second.

Similarly, for a 12-minute storm the maximum runoff is shown to be 237 cu. ft. per second, and for a 15.7-minute storm (15.7 minutes being the time for collection), 231 cu. ft. per second.

The sewer capacity, therefore, should be based upon the flow from an 8-minute storm, amounting to 243 cu. ft. per second.

The Vicari method, thus adapted to the practical solution of runoff problems, is not as difficult to grasp as to describe, and those intending to make use of it should consult one of the articles referred to above. It has the advantage of providing a rational result at any period of a storm of any duration and for any combination of subdistricts desired, practically without computation, tabulation or other work after the diagram has once been constructed. Whether or not it should be substituted for the usual method, involving computation and tabulation, depends upon the specific problem in hand and on the personal preference of the engineer, but it has been thought of sufficient value to be presented in this way for consideration.

FEATURES OF STATE HIGHWAY WORK IN MONTANA

By John N. Edy, Chief Engineer, Montana Highway Commission, Helena, Mont.

The outstanding features of the present situation in respect to highway improvemen work in Montana are as follows:

State Maintenance

For the first time in its history, the state will this year participate in the cost of and assume full responsibility for the maintenance of state highways improved under the supervision of the state highway department. Compared with the whole road mileage of the state, the mileage of state-maintained roads for this year will be very modest indeed. However, a start has been made along lines which are now recognized as proper and reasonable and state maintenance of important state highways will undoubtedly be a fixed policy from this time forward.

Maintenance will he accomplished by

means of patrolmen or section men under direct supervision of the state's maintenance division. No maintenance by contract is contemplated at this time.

1922 Construction Program

The volume of new work proposed for 1922 is considerably under the average for the past two years. This is due largely to the fact that county bond issues, which have been used by the state as a source of local funds to match Federal Aid, are very nearly exhausted. Since the department is going into the new season with less than a million dollars of uncompleted contracts the outlook for a summer of heavy work is not very promising. No contract lettings have been held this spring, although several small gravel road projects will be advertised soon.

In all probability the value of construction work accomplished during the 1922 season will not exceed two and one-half million dollars.

Suspension of Paving Activities

While this department has never built a considerable mileage of paved roads it is now planned to suspend all such activities for at least one year. There are several reasons for this policy. In the first place it is recognized that not over one hundred miles of Montana's sixty-seven thousand miles of public highways need to be improved at this time to a standard beyond that of a well built gravel road. Montana's road problem is decidedly one of securing maximum mileage, at a minimum cost, if necessary to the disregard of many of the refinements of location and design.

Again, the present and immediate future practice of the department will require that all paved road surfaces, whether of concrete or of bituminous concrete, shall be placed upon a sub-base of gravel or other suitable material. In connection with such applications for paving projects as may be received therefore the department will complete grading and drainage features as soon as possible and place a relatively thin wearing surface of gravel, which will serve the traffic adequately for the time being and offer a suitable foundation for the pavement when it is constructed.

State Funds for State Road Projects

Last fall it was thought that the department would promote a state road bond issue for submission to the people at the general election of this year and by means of which state road projects could be financed. Conditions in the state, however, have been such as to cause the department to abandon this program entirely. It is now believed that the only possible source of state revenue lies in a reasonable increase of motor vehicle license fees and an increase in a gasoline tax which is now 1 ct. per gallon. It should be noted, too, that the proceeds from the gasoline tax are now credited to the general fund of the state and it is proposed that the proceeds from this tax be made available for state highway improvements. While the department recognizes that many persons other than actual road users are benefited, either directly or indirectly, through the development of an improved state highway system, it is nevertheless a fact that for some time in the future the people who use Montana's highways must pay for their improvement

Volume of Traffic

The volume of trafic using Montana's roads is light, some of the most important interstate roads showing a maximum summer traffic of about 500 vehicles per day. In the vicinity of Butte, the largest city in the state, one road carries a traffic of approximately 2,000 vehicles and another a traffic of approximately 1,500 vehicles. In general this traffic consists of pleasure cars ,the maximum truck traffic on any highway in the state rarely exceeding 200 per day.

Federal Aid

All the work built by the department since 1919 has been with Federal Aid; Federal funds being matched with county funds. The state has had no money for construction. In 1921 the department received approximately $275,000 from motor vehicle fees, which was barely sufficient to carry the administrative and engineering charges of the department.

MANUAL OF OPERATION FOR USE IN MAINTENANCE OF LOUISVILLE SEWERS

By Ruth Canavan, Librarian for Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

Recognizing that adequate service of a sewer system can be insured only by its maintenance in proper operating condition, the Commissioners of Sewerage of Louisville have had published in separate form Appendix G of a recent report by Chief Engineer J. B. F. Breed and Consulting Engineers Metcalf and Eddy. This appendix, entitled "Manual of Operation and Maintenance of Sewer System, Louisville, Ky., October, 1921," is of pocket size and durably bound in canvas. In it are

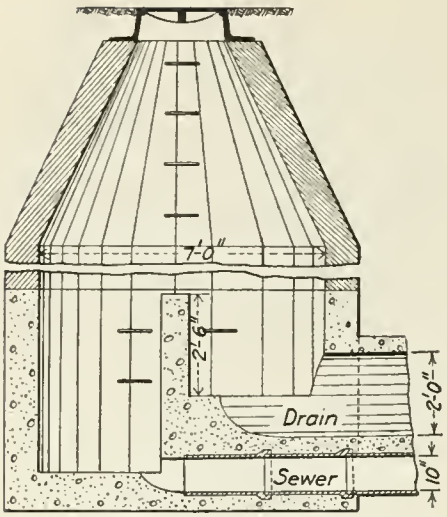


FIG. 1—SPECIAL MANHOLE ON ALTA AVENUE SEPARATE SEWER AND DRAIN, LOUISVILLE, KY.

included sections on the following subjects:

Care of Sewers and Drains,
House Connections,
Inlets,
Catchbasins,
Inverted Siphons,
Regulators,
Flood Gates,
Special Manholes,
Diversion Chamber,
Overflow Chamber,
Outlet Structures,
Gauging Chamber,
Beargrass Creek Channel.

The Manual also contains definitions of the various features of the sewer system and illustrations of typical and of particular structures.

In several instances special manholes have been found necessary, to meet unusual conditions for which the standard form was not suitable.

"Where a separate sewer and a drain are constructed side by side, or one above the other, a special form of manhole may be required, such as that shown in Fig. 1, which is on the Alta Avenue sewer. By drawing together the two compartments into a single shaft access is provided to both lines of pipes, with but a single cover in the street. In this case the drain is above the sewer and the division wall is provided to prevent the flow in one pipe, when operating under slight pressure, from passing over into the other. Unless the drain is maintained free from obstruction due to deposits or other clogging materials, there is danger that the storm water will overflow the wall and surcharge the sewer. Similarly the sewage may overflow into the drain, through which it may flow into one of the water courses and cause objectionable conditions. It is important, therefore, that

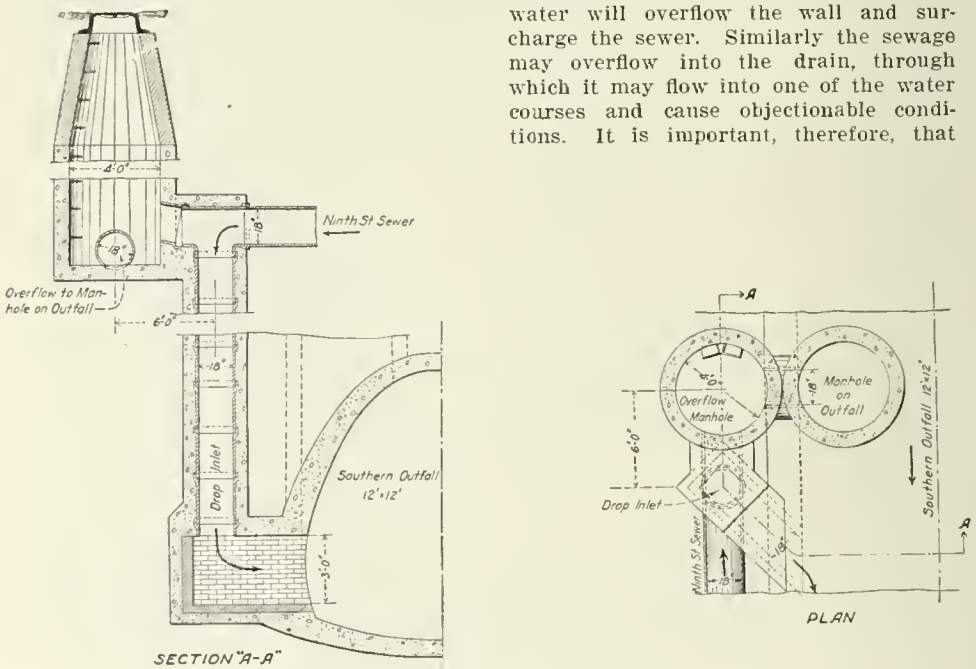


FIG. 2—DROP MANHOLE ON THE NINTH STREET SEWER, LOUISVILLE, KY.

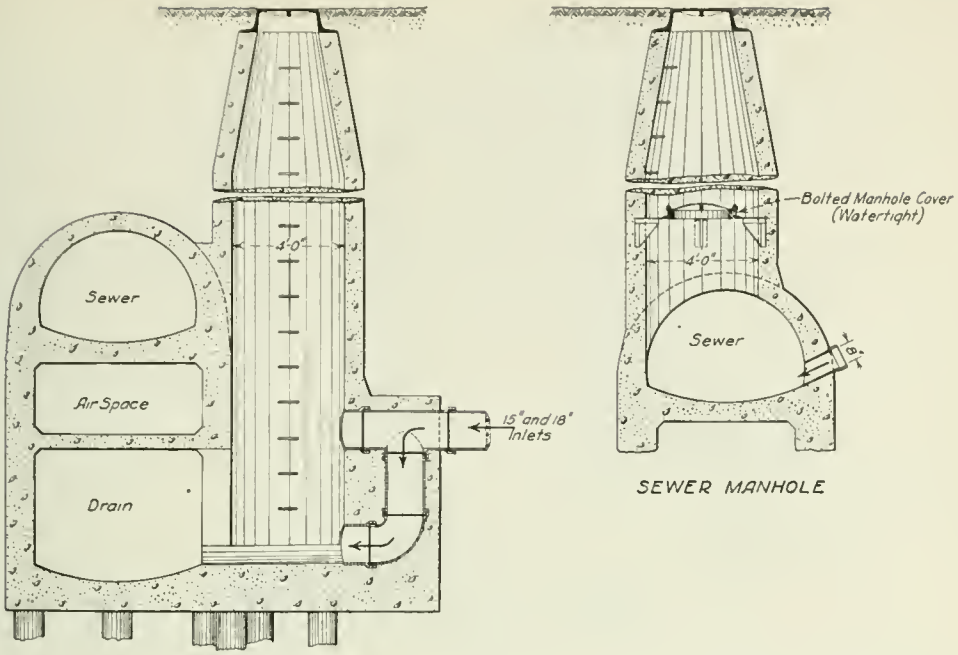


FIG. 3—TYPICAL MANHOLES ON THE NORTHEASTERN SANITARY TRUNK SEWER AND STORM DRAIN, LOUISVILLE, KY.

sewers and drains upon which manholes of this type have been constructed be inspected at frequent intervals, so that any obstruction may be discovered and promptly removed."

In cases where there is especial danger of overflow from one pipe into the other, separate manholes have been built.

Three drop manholes are also described, that on the Ninth Street sewer, Fig. 2, including provision for resisting erosion of the bottom due to the action of falling water, and others on Beargrass interceptor and the Northeastern Sanitary trunk sewer, where they pass through the district known as the Point, having been so constructed

"* * * as to prevent water from the river passing back through the sewers, overflowing the manholes and flooding the low ground behind the cut-off embankment. In some cases the manholes were simply constructed to a height equal to, or greater than, that of the embankment, and in others a diaphragm was provided (Fig. 3). The bolted diaphragm covers should be kept bolted down. The bolts and nuts should be kept greased so that the covers can be removed readily, and the metal work should be cleaned and painted at least once a year."

Eight pages of the Manual are devoted to "Inverted Siphons," that on Section A, Northeastern Sanitary Sewer (Fig. 4), being described as follows:

"This inverted siphon is constructed with three lines of pipe—one 18 ins. and two 30 ins. in size. The inlet chamber contains sluice gates controlling the flow into each of the siphon pipes, also a sluice gate opening into an overflow chamber. This latter gate should be closed except in an emergency. * * *

"If the flow of sewage reaching the inlet chamber is greater than the combined capacity of all three pipes, due to clogging or other reasons, the sewage will pass over into the emergency overflow and be discharged into Beargrass Creek.

"A clean-out chamber has been provided at the low point in the siphon, so that any one of the three pipes can be drained out. Sewage discharged into this clean-out chamber must be removed by pumping, to facilitate which a sump has been provided. In case it becomes necessary to enter any one of these pipes, and the work cannot be done through either the inlet or discharge end, a section of flanged pipe, located in this chamber, can be removed, thus providing access to any one of the siphon pipes at the low point."

A siphon consisting of a single line of 8-in. pipe, the flow of which is controlled by a regulator at the inlet end, is located on the Cooper Street sewer connection. On this siphon, also, a clean-out manhole has been provided, through which the siphon passes in the form of a flanged

carry the dry weather flow only, is illustrated by Fig. 5.

In the section devoted to outlets five structures are described, perhaps the most interesting being that of the Southern outfall sewer (Fig. 6), because of its fall of 34.2 ft. in a length of but 93 ft.

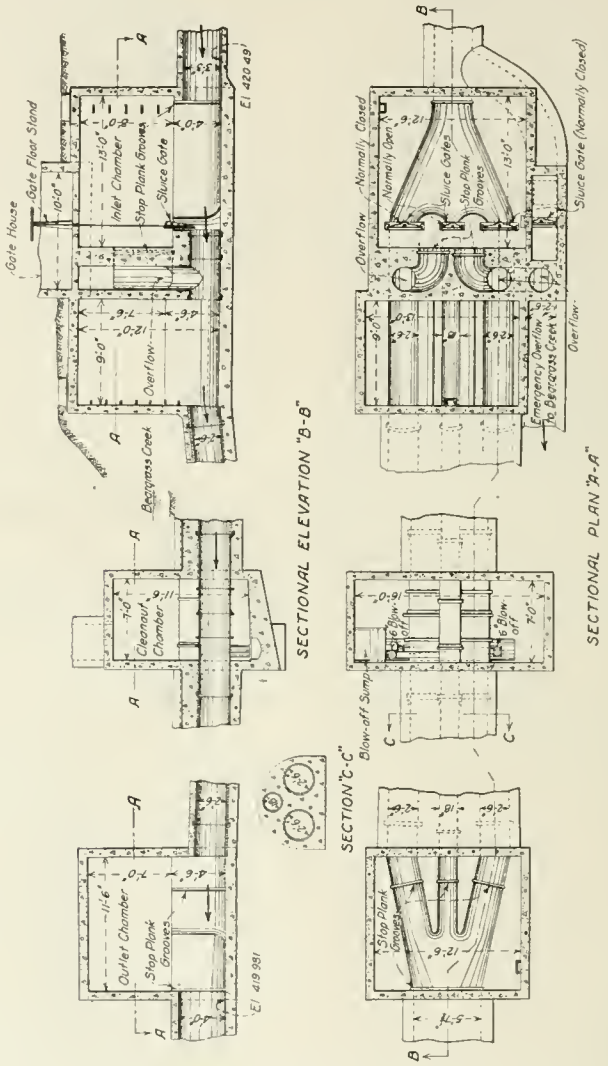


FIG. 4—INVERTED SIPHON ON SECTION A, NORTHEASTERN SANITARY SEWER, LOUISVILLE, KY.

cast-iron pipe. By the removal of one or more sections of this pipe access can be obtained to the straight run of pipe. An 8-in. gate valve in the manhole prevents entrance of backwater from Beargrass intercepter at times when the siphon is out of service for repairs or due to emergencies. This siphon, which is designed to

The dry weather flow channel, or cunette, in this section, is 3 ft. wide in the invert of the large sewer, and is lined with vitrified clay channel pipe.

"The remainder of the invert is lined with vitrified brick up to the beginning of the arch. Insofar as practicable, obser-

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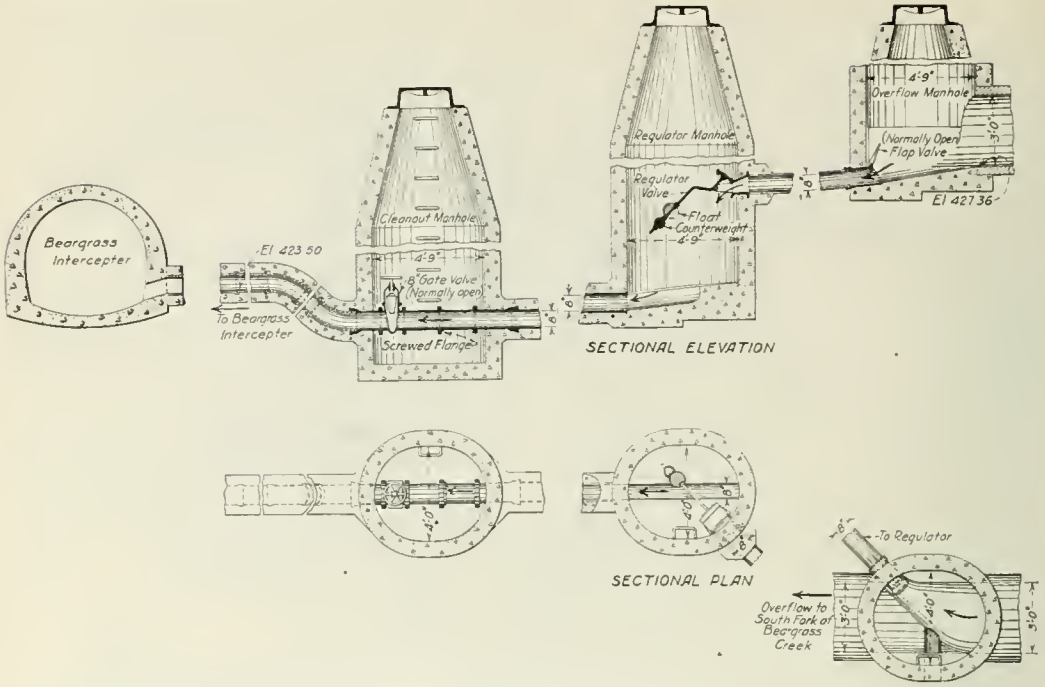


FIG. 5—INVERTED SIPHON ON COOPER ST. SEWER CONNECTION, LOUISVILLE, KY.

vations should be made from time to time to make sure that these linings are intact and have not been broken or worn by the flow. If required, repairs should be made promptly.

"The elevation of the crown of the outlet is * * * 5 ft. below the 9-ft. stage of Ohio River. * * *

"The foundation of the outlet is carried down to rock to guard against possible movement of the structure due to the sliding of the bank."

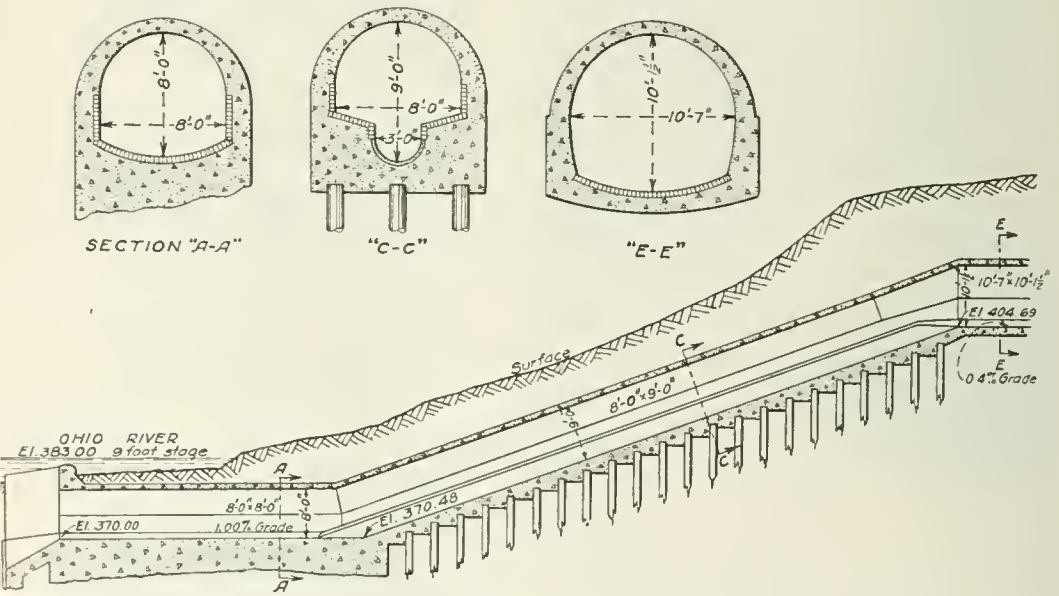


FIG. 6—OUTLET STRUCTURE, SOUTHERN OUTFALL SEWER, LOUISVILLE, KY.

WATER WORKS SECTION

WATER SUPPLY FROM GRAVEL STRATA

By John W. Toyne, Registered Engineer, South Bend, Indiana.

It is true that one of the earliest records we have of public water supply—Exodus, 17th chapter—is from rock formation, and also true that to the minds of a great many the development of a supply from rock is to be desired both from the standpoint of continuity and safety, but to the writer this is erroneous.

A great percentage of our area is ideal for the development from the gravel strata that underlies practically all of the territory traversed by the glaciers during their period and that have since been covered by a layer of soil especially adapted to the gathering of rainfall and carrying it to the gravel strata, from which it can be readily pumped.

Preliminary Studies

A careful study must be made prior to the actual development of this type of water supply, to determine the catchment area, the amount of precipitation, the percentage of evaporation and direct drainage from the area so that a rational estimate may be made of the probable supply available. Following this, tests should be made to determine the depth of the gravel strata, the character of the material and the direction and rate of flow in the vein. With these determinations made, all of the characteristics of the supply can be predicated very closely and the actual work of development can be proceeded with, or abandoned, as may be indicated by the preliminary engineering investigations outlined above.

Keep Log of Every Boring

With all due respect to the well driller, it is probable that no artisan appreciates the possibilities of his calling so little as the average well driller. The fund of valuable data that might have been accumulated from the records of drillings, had they been kept and properly classified, is almost beyond comprehension, and the unfortunate feature is that the practice of not recording the accurate log of every boring is to a great extent still current.

Having made the essential engineering investigations relative to the probable supply, a driller should be employed on the basis of his ability and equipment; an accurate log should be kept of the formations and a strainer selected suited to the material composing the water-bearing strata.

Removing Fine Sand

The writer has found in his experience that it is a mistake to attempt to screen out all of the sand, as is so often done. It is better practice, and more economical, to determine from a mechanical analysis of the water-bearing sand and gravel, the mesh strainer that will allow the free flow of the quantity desired, or possible, and then through thorough cleansing of the well in finishing it, remove the fine sand to such distance that a state of repose will continue in the strata under operating conditions with the coarser particles only next to the strainer.

Placing the Well Strainer

Two general methods are employed in placing a well strainer, and both methods have their advocates and advantages. One driving the strainer ahead of the casing, the other sinking the casing to the full depth of the finished well, then placing the strainer and pulling the casing back to expose the strainer.

To the writer, the latter method has so many advantages in its favor that he has adopted it as standard; samples of the material to be screened can be secured, accurate depths ascertained and probabilities of ruining the strainer avoided, all of which are essential.

Desirable Features in a Strainer

It should be understood that no brief is being filed for any particular type or manufacture of strainer, but a concise summary of essentials is desirable to a proper selection if maintenance is to be reduced to a minimum and continuous service secured. The first essential is, that it be of such type that a free flow of water from the vein is permitted without the probability of the finer particles clogging the openings; another feature to be avoided is, the conjunctions of different metals that may set up or facili-

tate electrolytic action. These, coupled with sturdy construction that will permit handling, should give satisfactory results.

If the above outline is followed intelligently, a satisfactory and economical water supply should be secured.

QUANTITATIVE DATA IN STREAM POLLUTION INVESTIGATIONS

By Earle B. Phelps, Consulting Sanitary Engineer, 30 Church St., New York, N. Y.

The purposes, methods and results of stream pollution investigations may be classified in two distinct groups according to the nature and uses of the stream itself. In the case of waters that are used as a source of domestic water supply, or that for any reason are to be measured and controlled by potable water standards, the primary purpose of an investigation is the determination of potability and sources of possible pollution. The methods employed are bacteriological, coupled with physical inspection of the water-shed and the results obtained are in the form of quantitative data capable of fairly exact interpretation in the light of our accumulated experience. Satisfactory progress both as to methods of study and as to the interpretation of the results is being made in this field and, while further improvement and new experience will undoubtedly be advantageous, it may be said that the situation as a whole is now upon a reasonably satisfactory quantitative basis. A single outstanding exception to this general statement is the question of the safe loading of a water purification plant and the associated question of the maximum permissible pollution of streams that are to be treated for domestic use. This field is today a sort of "no-man's land" in which there is considerable activity and over which there is much concern but thus far there is not only a lack of agreement on the major question but also lack of any authoritative view as to the proper basis for quantitative investigation.

The Investigation of Non-potable Streams

It is, however, in the investigation of the non-potable streams that the need for quantitative methods and data is most urgent and it is with this question that the present discussion has to deal. Streams which by common consent are given over to the purposes of drainage, to the exclusion of domestic water supply use, are, or should be, undercontrol in order that their various possible uses may be developed and conserved at the point of maximum utility. The purpose of an investigation of such a stream is to determine the amount, character and effect of the various kinds of drainage which it receives; the method is primarily chemical or bio-chemical, and the results should be a quantitative expression, not only of the general result but also of the distribution of the responsibility among the various sources of pollution, of the progressive effect of the pollution as it passes downstream and of the ability of the stream to return to its normal condition.

Need for New Method of Stream Examination

The chemical methods of stream examination that were generally employed a decade ago were incapable of dealing adequately with this problem. They were the methods employed in the so-called sanitary analysis of water, and before the advent and general adoption of the bacteriological methods they had a certain, although quite limited, field of usefulness in determining potability. The pollution of non-potable streams, however, by industrial and domestic wastes may lead to nuisance or stream impairment of one kind or another, depending upon the character of the waste. The determination of this effect must be based upon a knowledge of stream conditions coupled with analyses of the wastes themselves, that have direct relation to and bearing upon the kind of nuisance anticipated. The analytical scheme, therefore, cannot be a general or blanket one but must of necessity vary with the nature of the problem. Sanitary chemists have been too content in the past in resting their case upon the established schedule of sanitary water analysis regardless of the nature of the problem, and engineers, while recognizing the futility of much of this work in the practical solution of stream pollution problems, have not in general learned that better and more specific methods are readily at hand.

Since the analytical scheme as well as the entire course of the investigation varies with the nature of the waste, it will be well at the outset to classify domstic and Industrial wastes according to their possible harmful effects upon the stream. For the purpose of the present general survey of the situation the following classification, though incomplete, will serve.

Classification of Domestic and Industrial Wastes

1. Wastes that in themselves are directly injurious to the stream in one or more ways. These include:

(a) Toxic substances injurious to stream life, such as acids or alkalies, copper salts, compounds containing arsenic, phenols and other poisonous organic compounds, etc.

(b) Materials capable of settling which, regardless of their other properties, may cause undesirable deposits.

(c) Dyes and coloring matter, material in a fine state of subdivision such as clay or lamp-black and oils, all of which may affect the appearance of the stream; and substances which give to the stream undesirable odors.

(d) Substances which adversely affect the chemical composition of the water with regard to industrial or other use.

2. Wastes which tend to decompose or putrify in the stream, leading indirectly to conditions of nuisance or of depreciated stream value.

Discussion of Harmful Effects

Since this classification is one of nuisances or harmful effects, rather than of industries, it will readily be seen that any given industrial waste may belong to two or more of these subdivisions. Domestic sewage for example belongs to divisions Ib, Ic and II.

In the investigation of pollution due to wastes of the first group—the directly injurious wastes—the course of procedure, although never standardized, is fairly well indicated in each particular case and the analytical results should be definite and quantitative. These results, properly interpreted in connection with data on the physical characteristics of the stream and its uses furnish a direct basis for the conclusions of the investigation.

Wastes of the second class, those which damage a stream by their decomposition are much the more common type and their study is, unfortunately, less simple. The effect of this type of pollution is neither direct nor immediate. It may be entirely absent immediately below the point of discharge and assume its maximum intensity many miles below.

The Bio-Chemical Oxygen Demand

In general the actual harm results from the partial or total depletion of the normal dissolved oxygen of the water and associated chemical changes, leading to the destruction of stream life, and general unsightly and malodorous conditions. In the methods of investigation of this type of pollution great advance has been made during recent years. It has been found in brief that the bio-chemical oxygen demand of the waste is an accurate and quantitative measure of its effect upon the stream. For example if the waste as it flows from the sewer has an oxygen demand of 200 parts per million, in 24 hours at 20 deg. C., and if the dilution of this waste in the stream be one hundred fold, then at the same temperature in the stream, two parts per million or 16.7 lbs. of oxygen per million gallons of stream flow will be abstracted from the stream during the ensuing 24 hours of flow. The demand for 48 hours or for any other period, and the effect of various temperatures, may likewise be determined. In the case of a waste which contains material capable of settling and which is discharged under conditions which favor sedimentation, the settleable and non-settleable portions of the waste may be examined separately and for different periods of time corresponding to the time each remains within the area in question and the total effect of the waste will be the sum of these.

New Method of Study Substantiated

The writer has recently had occasion to utilize this method of study in a case which involved the probable cause of the destruction of fish which has occurred during several summers past. Despite the fact that the work had to be done during the winter months, it was possible to determine separately the effects, under summer conditions, of the sewage of a city, and of the wastes of certain industrial establishments and to distinguish these quite sharply from the residual effects of certain up-stream pollutions of unknown character and amount. Actual warm weather determinations of the dissolved oxygen of the stream above the sources of pollution and at a point downstream sufficiently far to have developed the maximum effect, were later available, and, despite the complications of the situation, the stream condition, as thus measured, agreed well with the results computed from the examination of the properties of the polluting wastes and the respective volumes of flow of the wastes and the river. This case is at present before the courts and may not be discussed in detail at this time but it may be said in general that a proper use of the newer methods of analytical chemistry in the field of stream pollution will furnish the necessary quantitative data for the solution of many of the complex problems that are arising with increasing frequency in the practice of sanitary engineers. The bio-chemical oxygen demand of city sewage, exclusive of industrial wastes, is now so well established that it may be applied at once

to any given population without further study. Similar standardization of the values for certain of the more standardized industries, upon the basis of output, is desirable and is being gradually attained. The employment of quantitative data will go far toward placing the subject of stream pollution and its control upon the accurate scientific basis which its importance justifies.

MISADVENTURES IN WATER SUPPLY AT SAGINAW, MICH.

(Editor's Note:—Some friend, who does not reveal his identity, has sent us a marked copy of the *Detroit Saturday Night*, for June 17, 1922, calling our attention to an article pertaining to the water supply situation at Saginaw. We have so much enjoyed reading it that it is reproduced here as a splendid example of humorous treatment of a municipal engineering problem. As originally published the article appears under the striking title, "The Gods Are Kind to Saginaw; Residents Drink Mud and Live." The subtitle is even more striking—"For the Last 16 Years This City of 61,000 Germ Imbibers Has Been Trying to Obtain a Pure Water Supply, and Though It Has Spent Much Money and Has Run the Referendum Ragged, It Is Right Where It Started, Except That a Solution Now Seems Impossible." Perhaps it is not so bad as that. Still, a city that tolerates such a situation cannot expect to escape a little good-natured joshing. Credit for the authorship of the article belongs to Alfred J. Fischer, Special Correspondent of the *Detroit Saturday Night.)*

The other day—and this is supposed to be a true story—a traffic officer in Flint arrested an autoist and haled him into court.

"You are charged with running past a standing street car," said the judge sternly, "and at the station they found a case of beer in your automobile. You don't look like a vicious citizen or a bootlegger, yet you endangered the lives of passengers and broke the law regarding liquors. What have you to say for yourself? Where do you come from, anyhow?"

"Saginaw," murmured the humble flivverist.

The judge looked at the meek culprit compassionaely. Then he turned to the prosecutor.

"I don't think we ought to press this case. Why, this poor man comes from Saginaw. The people there have not seen a street car for months, and if I lived in a burg where everybody had to drink mud highballs, I think I would take a chance on smuggling in a cold bottle myself. Case dismissed. Go home and keep away from a regular city."

That was the first bit of anecdote and comment given the writer when he dropped into Saginaw a few days ago to investigate why Michigan's fourth city, with a population of 61,000 germ drinkers, is still pumping mud into its mains after 16 years of agitation for pure water. Since 1906 there have been nine referendums on a total of 13 questions dealing with pure water supply. During this time hundreds of houses were built and every time one was constructed, a little hand pump was installed back of the kitchen door, as is still done in Lima Center and Hatch's Crossing (you'll find them both in the gazeteer).

Saginaw gets its water from the Saginaw River. The stream has played the town other mean tricks besides acting as its namesake. You know how rivers take on personality and become famous for their color or characteristics. There is the Blue Danube, for instance, and muddy Maumee. Well, the Saginaw River would defy the efforts of pbrase-makers and alliterationists if its color were to be linked with its name, for it is a sort of henna shade most of the time. Still, it might be called the Solid Saginaw, because those who know say that it supplies both food and drink to its consumers.

The agitation for pure water in Saginaw began in the early part of the twentieth century, anno domini. There was then a population approaching 50,000 and it became apparent that something should be done. The records show that for $400,000 a filtration plant and pumping station could have been constructed. When the matter was put to a vote at a referendum in April of 1906, it was defeated almost three to one.

That was the beginning of a series of elections that must have made the inventor of the referendum not merely turn over in his grave—if he is dead—but spin around in it. They voted money for engineers to determine where an adequate water supply could be obtained. They voted to have other engineers check up the first batch. They decided to get water from Saginaw Bay, which like Winchester, was 20 miles distant. They had all the plans prepared by the best engi-

neers in America, right of way partly bought and partly optioned; pumping station sites procured at either end, mains extended in the city to receive the A. Pura, and then, as we say in the movie sub-titles—

They decided the Bay water project wouldn't do, that the real simon pure stuff was in the Shiawassee River, and they voted the whole business down. They started over. They referended some more. They have spent enough money on elections and electioneering in the past 16 years to build a pumping station and have enough money left for machinery and a barbecue on the day it would be started up.

From this point on, it will be necessary to mix metaphors for Shiawassee water, riding into fame as a political football, began to have hard sledding. Some of its friends did not like the ideas of Saginaw Bay adherents on street railway matters and other local issues, so that it did not take long for two factions to form —each number considering themselves irreconcilables. The industrial element for the most part favored the bay plan, because the water was softer and would be easier on boilers. Bay water would cost more at the outset to obtain, but once the initial plant was constructed, there would be no expense of softening. The Shiawassee River folks emphasized the economy of installation, since much of the way between the source and the city pumping station could be by an open canal, easy and economical to construct.

Both sides have been mortally offended by the tactics of the opposition, so that the antis to any given scheme, whatever it may be, plus those who have installed elaborate filters in their homes, added to the large volume of voters who are opposed to public improvements because they do not like the mayor or the city assessor, plus the friends of a cause who stay away from the polls entirely, are always numerous enough to defeat whatever proposed solution goes on the ballot.

In 1910, after four years of agitation since the first effort to settle the matter, the same plan went before the people again, and this time it lost by only 342 votes of the required three-fifths majority, with about 7,000 votes cast. From then on, at every election except one, the water referendums carried by straight pluralities but never received the required three-fifths, until the last time, in April of this year, when a referendum to raise the city's bonding limit and another to bond for $2,800,000 to provide Shiawassee water went down to stinging defeat.

There was one exception to this dreary record, and that was early in 1920, just before the slump in business. Saginaw was like a little teapot, bubbling over with optimism. The General Motors Corporation had constructed several large units, adding millions in property values to the city; houses were going up all over town, bank clearances were reaching new heights, and everything was just grand. Allen Hazen, one of the foremost engineers on water supply in the United States, had come out from New York and laid down a program based on months of careful research. He had been checked up by Gardner S. Williams, of Ann Arbor, another consulting engineer with much national experience. It was decided that for a town growing as rapidly as was Saginaw, with the prospect of some day annexing many of its suburbs, such as Flint, Bay City and Highland Park, nothing would be too good.

Accordingly, on February 24, 1920, there was an election at which everything carried. By a margin of 2,005 votes above the required three-fifths, out of a total of 7,800 ballots cast, it was decided to appropriate $500,000 to start work, buy land and make extensions to mains. A majority of 2,780 voters decided in favor of the Saginaw Bay project as against the Shiawassee. The problem was solved. The half million was almost entirely spent for right of way, additions to the city distribution system, station sites, and $81,000 went for a complete set of plans needed by the contractors. The 1921 legislature, at one of its flock of special sessions, took time out from quarreling about the rate of interest to be paid on bonus bonds, to permit the City of Saginaw to increase its bonding limit sufficiently to cover the cost of the improvement. Visitors were told with pride how the matter was settled after 15 years of bickering.

But alas, for the deluded mortals who took that much for granted. The program voted was a prosperity issue. With the passing of the silk shirt days disappeared also the enthusiasm for the $5,000,000 program. Hadn't they gotten along this far with river water, deep wells on every street corner, and hand pumps? Hadn't there been wonderful progress made in house filters? Hadn't the courts enjoined some of the big corporations inland from polluting the streams quite so much? What was this conspiracy on the part of the big business interests to load

taxes on the people, burdens to be carried by generations yet unborn! Were the city fathers competent to supervise this tremendous effort? Weren't the folk who wanted to pipe the bay water to Saginaw at a cost of millions the same people who wanted to sell the city out to the street railway? Abas! Selah! Thumbs down!

Now there had arisen during the good times when things went so well a citizens' water committee headed by Arnold Boutell, a manufacturer and highly esteemed civic leader. He had won the only victory ever achieved by combining all the forces, civic, fraternal, mercantile, professional, in the interests of a solution. When he saw the tide turning and politicians riding into power by opposing the program which had once been voted by such a splendid majority, he decided that in order to silence the opposition and retain unity, there ought to be another referendum. The Shiawassee project had gained many friends. They were entitled to another defeat and his committee wanted a vote of confidence. Therefore another election was held on December 7, 1921.

There were two questions. The voters were to decide again whether they wanted Bay water or Shiawassee water. They were also to cast 60 per cent of their ballots for sufficient bonds to carry either program. If Bay water carried and bonds received the needed majority, then $4,300,000 would be raised, the cost having come down slightly since the proposition was first submitted. If Shiawassee water won and enough votes were cast to allow issuing bonds, then the total was to be only $2,800,000. When the official figures were in, the bonds lacked the needed percentage by 888 votes, although they had received a plurality of 414 votes. Also, the Shiawassee plan was carried by a vote of 4,830 against 4,554.

It was a bitter pill. All the work that had been done, all the money spent for plans on the bay project, was wasted, and lines of discussion and opposition were more sharply drawn than ever. The Bay project blue prints can be bought for old paper.

The curtain rises again. There has been a lapse of five months since the last act. The street corner pumps have served as well-reared pumps should. The business slump has had its deadening effect. The corner has been turned. Normalcy is assured. The Saginaw River continues to give up its liquids and solids.

The water problem had been filed in the archives for a time since there had been other things to quarrel about. Into the limelight had come the street railway issue. A ten-cent fare had been inadequate to meet expenses of operation against jitney bus competition, and the company wanted relief to keep out of a receivership. None was forthcoming, so the cars went into the barns and the company went into bankruptcy court. That was in August, 1921. The jitney men promised to meet the transportation needs. Glib salesmen for motor bus builders tried to float companies, so they could sell them vehicles. It was a great season for the smokeshop experts while it lasted.

In the middle of it someone started in again to settle the water question. Shiawassee water had won in the last engagement and should be voted upon exclusively. A bond issue of $2,800,000 was submitted again, together with a clause permitting the city to amend its charter in accordance with the legislative enactment increasing the bonding limit. Both went down to disastrous defeat. The water bonds lost by 1,085 votes and the charter clause by 970 of the necessary three-fifths. In each instance the simple plurality was not received.

The writer was taken over the city to visit the pumping stations of which there are three. At the sight of the first he was reminded of a production of "The Flying Dutchman" staged some years ago by David Warfield. He was again viewing the deck of the phantom ship and hearing the old men of the crew moaning down in the hold, begging their captain to atone for his sins, so that they could die and have rest. For half a century the pumps have creaked their way through time, serving bisque to young and old, rich and poor. Season after season the water has come to them from the sources of the Tittabawassee, Cass, Flint rivers and other streams, flowing past the sugar beet and chemical plants, and moving on friendlessly until the pumps sent it throughout the city. Kind-hearted fire underwriters have condemned the boilers which serve as taskmasters, but the city will not replace even these, since it is hoped that some broader plan may be adopted any day which would cause replacement cost to be wasted when the stations were scrapped.

There are two such stations, one on

either side of the river. The third one is a dapper little spot where two trim, modern electric pumps help out with about 4,500 gallons a minute and increase pressure throughout the congested sections of the town. That the venerable pumps consume far greater quantities of coal than modern ones, that constant breaks make it necessary to fabricate new sections in an eastern foundry cannot be helped.

Lack of leadership is given as the cause by those who pretend to know. The controversy has created thousands of what is known as "curbstone engineers," each of whom has a solution and will not budge in the interest of a settlement. It does not make it any easier that the city recently amended its charter and installed a commission form of government as an efficiency measure. This plan provides for election of councilmen at large and the winners are placed at the heads of various city departments. The city engineer, a technical man, must look to his fences, and whatever he plans or inaugurates may be upset if his opponent, possibly an ex-bartender, should be able to poll a few more votes.

There is also much feeling over the law which requires a 60 per cent majority to amend a charter or vote bond money. Those who have studied the situation in Saginaw state that there are always 20 per cent who oppose anything progressive, making it necessary to recruit the winning votes from those who are left. In March, 1915, a referendum for $675,000 for a consolidated pumping station, filtration and softening system lost by only 58 votes of the needed majority. That number of Saginaw citizens who were known to be favorable to the proposition were in California at the time, and if the absent voters' law could have been invoked then in the interest of the improvement, things might have been different.

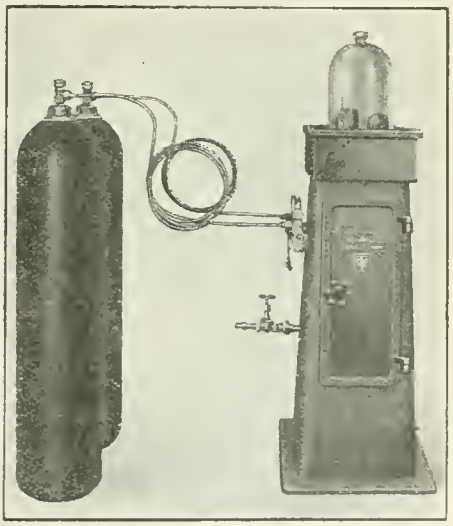
Nobody pretends to know what the next step will be. Everybody has been vindicated and everybody has been defeated. One city official was asked what the history of Saginaw's water problem might have been if the matter had been left to private enterprise, and he looked so dangerous that the interviewer did not pursue this line of discussion.

The last word on the subject was by an editorial writer on the Saginaw News Courier who advised his readers not to weaken.

THE "W. & T." VACUUM FEED CHLORINATOR

The "W & T" Vacuum Feed Chlorinator is a self-contained unit, exceedingly simple to install and operate. It is built with the pedestal type of mounting, and with the chlorine pressure reducing and constant rate of control mechanism housed under a glass bell jar in a rubber tray container at the top of the pedestal. The chlorinator is illustrated herewith.

To install the equipment it is necessary only to set at a suitable location on the floor of the pumping station, connect up a water supply line to the gate valve at the lower left hand side of the pedestal, connect the cylinder of chlorine to the chlorine gas valve at the upper left hand



THE W & T VACUUM FEED CHLORINATOR

side of the pedestal, and connect the solution discharge line, which is shown projecting out to the right at the base of the pedestal, to the desired point of application in an open well or into a main.

The chlorine gas comes in through the chlorine manifold valve above referred to and the pressure of this gas is indicated on a gauge just behind this valve on the manifold. From the manifold the gas passes up through a silver tube to a ball float type of reducing valve housed under bell jar.

Located in the base of the tray at the center part is an injector for making a solution of chlorine and water. The water supply is admitted through the gate valve at the lower left hand side of the pedestal, passes in through a water strain-

er where the pressure is indicated by means of a gauge at the top of the strainer housing, then passes through a water pressure reducing valve and up to the injector. A gauge is provided on the discharge side of the pressure reducing valve to indicate at all times the reduced pressure which is the operating pressure of water at the injector throat. The vacuum produced by the flow of water through the injector produces a vacuum in the bell jar, this vacuum being transmitted to the bell jar through the meter tube assembly. The only communicating ports between the meter tube assembly and the inside of the bell jar are small ports below the water level in the jar, and the calibrated orifice at the top of the meter tube. Projecting up in the center of the glass meter tube is a silver tube, the height of which is adjustable by means of the rack shown at the middle right end of the pedestal. The suction port from the injector throat communicates directly with the interior of the glass meter tube through the inner silver tube and produces a vacuum in this tube which must be satisfied either by water which is carried up through the communicating ports at the bottom of the glass meter tube, or by gas which is admitted through the calibrated orifice at the top. It will thus be seen that the differential head on the calibrated orifice may be directly controlled by the height of the inner silver tube inasmuch as when a suction is produced on this inner silver tube, the water will be carried up into the glass meter tube to a point where it is sucked over into the inner silver tube above. The height of water inside of the bell jar will be the differential head across the calibrated orifice.

Inasmuch as the injector is pulling a vacuum on the meter tube, and this must be satisfied from the interior of the bell jar, a partial vacuum will be produced inside of the bell jar which in turn will tend to raise the water level inside the bell jar and will so raise the ball float which controls the gas inlet valve to the tray. This will permit the chlorine gas to pass into the bell jar, from there through the calibrated orifice into the meter tube and to the injector throat, where it will be absorbed by the water passing through the injector, and the resulting solution of chlorine and water will be lead away through the solution discharge hose to the desired point of application. It is obvious that if gas is admitted to the bell jar more rapidly than it is taken out through the meter tube, the partial vacuum in the bell jar will be decreased, the water level inside of the bell jar will fall slightly, and cause the ball float mechanism to drop, so throttling down the supply of chlorine to the bell jar until a condition of equilibrium is reached.

Conversely, if the supply of gas to the bell jar is not sufficient to satisfy the demands of the injector through the meter tube, the partial vacuum inside of the bell jar will be increased causing the water level inside of the bell jar to rise and open further the chlorine inlet port, so admitting chlorine gas to the bell jar at a greater rate until the demand is satisfied. It will be seen that this arrangement forms a constant flow device which will give a uniform flow of chlorine through the apparatus for any setting of the adjustable silver tube inside of the glass orifice meter tube. The equipment is so designed that the variations in height of the silver tube may be controlled at any desired height of from zero to 8¼ ins., and the glass orifice meter is therefore designed in each equipment to give the maximum rate of flow for that particular capacity of apparatus, with the maximum height of the silver tube inside of the meter tube, i. e., about 8¼ ins., and this height will be the maximum differential which may be obtained through the orifice.

There is a small float valve mechanism which admits the necessary water to the tray to make up for that which is being constantly drawn in through the meter assembly.

Inside the bell jar in addition to the ball float reducing valve and meter tube, there is provided a ball float vacuum relief valve which admits air to the jar if the water supply to the injector is turned on without the chlorine supply to the apparatus being turned on. This prevents excessive vacuum being produced in the bell jar which would raise the water to such a level that it would get back into the gas inlet connection. It further functions to allow any leakage through the chlorine float reducing valve to escape to the outside atmosphere instead of being discharged into the room in case the equipment is left for any length of time with the water supply shut off but with the chlorine turned on.

The Vacuum Feed Chlorinator presents many new features in the control and application of chlorine which appeal to the water works operator. It is rugged in appearance, all parts are very easily accessible and the entire equipment can be disassembled for cleaning and reas-

sembled even by a novice in less than an hour's time. All operating parts are visible—there are no bolts to remove to enable one to get at the reducing valve mechanism. It is simply necessary to shut off the gas, allow the water supply to continue to run for a few moments, then lift the bell jar out of the tray and all the elements of the reducing valve control mechanism are exposed for cleaning. The water supply line is equipped with a large area strainer of special design which minimizes the frequency with which the screen must be removed for cleaning. The water pressure reducing valve is also of special design having been particularly developed for use with this type of equipment to give the minimum loss of head through the valve and yet hold the reduced pressure constant at all times regardless of the inlet pressure applied.

Inasmuch as the equipment always operates under a partial vacuum, it can be operated with lower chlorine pressure in the containers than any other type of chlorine control equipment, and will function perfectly with chlorine pressures as low as 25 to 30 lbs. per sq. in., which represents the pressure of chlorine at about 15 deg. Fahrenheit. This means also that it is more easy to get all the chlorine out of the chlorine cylinders.

Repair charges are also reduced to a minimum inasmuch as there is absolutely no possibility of getting moisture back into the gas line with the resultant corrosive action.

The most notable feature with respect to this type of equipment is that when the water supply to the apparatus is shut off, the flow of chlorine is automatically shut off by means of the ball float reducing valve and consequently there is no possibility of chlorine gas escaping into the pumping station because of failure of the water supply to the apparatus.

SMALL INDUSTRIAL SEWAGE TREATMENT PLANT

By George L. Robinson, Consulting Engineer, 5621 Grand Central Terminal, New York, N. Y.

The Haberland Manufacturing Company, located near Paterson, N. J., will employ a maximum of 420 persons. It is estimated that the domestic sewage production will not be over 50 gals. per person per day. The nature of the sewage will be purely domestic. There are no laundries or kitchens, and there will be no trade wastes discharging into the sewer.

It is proposed to take the sewage from the building through a 6-in. sewer to the treatment plant. This plant consists of the following elements: Gate Chamber, Settling Tanks and Chloride of Lime Sterilizing Outfit.

Gate Chamber

This is a concrete structure, semi-circular in form, provided with two stop planks, or gates, set in the invert of the sewer, which will be moulded in the concrete floor. These gates are to be of wood provided with steel strap handles painted with creosote paint. They fit in a slot moulded in the concrete at right angles to the invert. A wrought iron or steel door, lifting with hinges or otherwise, is to be provided in the roof for easy access to the gates.

Settling Tanks

The flow of sewage water from the factory may be deflected into either or both units of the settling tanks. When the total population is in the factory, each unit, consisting of the tanks, is to be worked for six months at a time, the organic matter standing in the one unit and digesting for six months, at the end of which time it can be removed by a hand pump through the covers of the roof.

The sewage will enter each tank from the gate chamber by means of a 6-in. vitrified or cast iron soil pipe Tee.

Each tank will be 9 ft. long and 6 ft. wide, having a maximum depth of 8 ft. The baffle wall will extend across each tank 1 ft. from the overflow end. The dividing wall will be beveled in the form of a weir.

The entire structure is to be built of concrete. The floor is to be 6 ins. thick and walls to be 8 ins. thick. The floor is to be reinforced by approved wire mesh or other metal. The walls and roof are to be reinforced by ½ in. steel deformed rods set at intervals of 18 ins. staggered in the vertical direction and 2 ft. horizontally on centres.

If the contractors prefer to bring the baffle walls up to the underside of the roof, they may do so, making due allowance for the manhole openings at the outlet end. Manhole openings in the roof will be provided.

Sterilizing Outfit.

The sterilizing outfit will consist of a concrete tank. This tank is divided into two parts, each 4 ft. long and 3 ft. wide. The walls are to be 4 ins. thick, made of concrete mixed with waterproofing.

Only one-fifth of the buildings owned by the Bell System are shown in this picture.

A Telephone City

Above is an imaginary city, made by grouping together *one-fifth* of the buildings owned by the Bell System, and used in telephone service. Picture to yourself a city *five times* as great and you will have an idea of the amount of real estate owned by the Bell System throughout the country.

If all these buildings were grouped together, they would make a business community with 400 more buildings than the total number of office buildings in New York City, as classified by the Department of Taxes and Assessments.

Next to its investment in modern telephone equipment, the largest investment of the Bell System is in its 1,600 modern buildings, with a value of $144,000,000. Ranging in size from twenty-seven stories down to one-story, they are used principally as executive offices, central offices, storehouses and garages. The modern construction of most of the buildings is indicated by the fact that the investment in buildings is now over three times what it was ten years ago.

Every building owned by the Bell System must be so constructed and so situated as to serve with efficiency the telephone public in each locality, and to be a sound investment for future requirements.

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The structure will rest on concrete piers 12x12 ins. at an elevation of 3 ft. above the finished floor. In the upper part of each storage tank will be a mixing trough 12x12 ins. inside dimensions, each trough to be 4 ft. long. A 2-in. hole will be provided in each trough, each fitted with a wooden plug, brass ring and chain. In front of this structure will be a small wooden platform.

From the bottom of each storage tank will extend a brass pipe to an automatic dosing box. This 2-in. brass pipe will have two valves.

On the floor in front of the storage tank and directly over the brick well will be set an automatic dosing orifice box such as is manufactured by the Roberts Filter Manufacturing Company of Darby, Pennsylvania, or equal.

A 1-in. water pipe will be provided to the mixing trough and a piece of hose about 2 ft. long provides so that water may be distributed into either of the mixing troughs.

This entire structure will rest on a concrete floor and should be enclosed in a neat wooden house of suitable dimensions.

The overflow from the settling tank will pass through a 6-in. vitrified pipe and make connection with the mixing chamber.

ENGINEERING IN THE SMALL MUNICIPALITY

By E. G. Orbert, Consulting Engineer, 627 M. & M. Bank Bldg., Milwaukee, Wis.

The small municipality frequently presents problems which are, in a way, more difficult of solution than those of the larger cities. This is usually due to the engineering (or rather lack of engineering) which has been practiced in such towns in the past.

It was formerly the custom to call in some local or county surveyor to lay out any improvement of whatever nature, or in the case of sidewalks the contour of the ground was too frequently taken as the established grade as "fitting the property" best. Now the old-time county surveyor may have been an excellent man *as a surveyor;* he may have been able to establish the property lines much better than an outside man could have done, but his lack of experience in other problems in all probability led to mistakes which are almost impossible to correct at the present time. Sewers were built too small, or by piecemeal without any comprehensive plan for future extensions; street grades were practically fixed by permanent structures, such as sidewalks, buildings, etc., without much apparent attention to drainage.

One of the worst and most frequent obstacles to overcome, already referred to, is the disregard to the future in laying concrete sidewalks. The writer has time and again encountered cases where the sidewalk on one side of a street was 3 or 4 ft. higher than on the other, or where there was a dip in the middle of a block which, when paving the street, necessitated several hundred feet of storm sewer which could have been eliminated in most cases by the establishing of a proper grade in the beginning.

The extra expense involved in correcting these early errors and in fitting the conditions as they are found, so as to cause the least damage to property, almost invariably costs the municipality several times what a competent engineer would have charged for establishing the street grades, or for drawing a sewerage system plan.

The great difficulty has been in the past, in educating the public to a realization of the necessity for this preliminary work. The average village official is under-paid, or not paid at all, and cannot be expected to devote much of his time to the study of municipal economics. However, the influence of state organizations, such as boards of health and highway departments, is gradually being felt, and it is becoming more frequent for the consulting engineer to be called in either to take charge of a proposed improvement, or as consultant to the local engineer, or surveyor, and it is to be hoped that local authorities will come to realize that it is no more a reflection on his ability or intelligence to do so, than it is for the local physician to call in a specialist for consultation on an important or especially difficult case.

STATE DEPARTMENT USES RADIO

State Highway Commissioner Frank Page of North Carolina, will have installed in his office in Raleigh a radio broadcasting station and receiving stations in each of the nine district offices located at Tarboro, Kinston, Wilmington, Durham, Greensboro, Charlotte, Elkin, Marion and Asheville. With this equipment the administrative forces of the Commission will be able to get in immediate touch with the construction and maintenance engineers throughout the State and thus effect a saving of several hundred dollars per month in telegraph tolls and in stenographers services.

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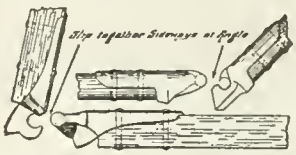

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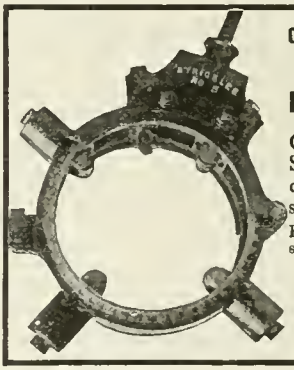

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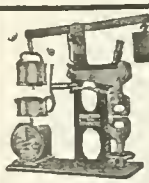

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Construction News and Equipment

SUCCESSFUL USE OF CORE DRILL ON INDIANA STATE ROADS

A few months ago the Indiana state highway commission purchased a machine for drilling cores out of hard surface pavements. It cost $1,200 and its acquisition is to determine if contractors lay concrete pavement according to specifications, especially as to the designated thickness of slab.

The first test was made in Lake county on a section of the Lincoln highway, and 1,200 ft. of pavement rejected as not up to specifications. The contractor decided to give the inferior pavement to the state rather than tear it up and rebuild it, so approximately $6,000 was deducted from his contract price in final settlement.

Lately by the purchase of equipment costing $250 the core driller can be used for bridge foundation exploration. The driller cuts a core four inches in diameter out of solid rock, and when this core is tested in the commission's laboratory, engineers seeking to locate a solid foundation beneath the earth's surface and frequently far below a river bed, know positively what strength the foundation will be which is to support the bridge crossing.

This machine has paid for itself many times in the short time it has been in use in Indiana, and it is one of the best investments the Indiana state road body ever made, says a recent press release of the commission. Indiana is one of the early states to adopt the core tester, and its advent into state road work was opposed by some people on the ground it was unfair to contractors. The commission takes the position that Hoosier roads and bridges must be according to specifications, and its use is with fairness to the taxpayers.

The first place where the tester, after being equipped for bridge foundation exploration, was used, was in Orange county near French Lick where the highway body is building a concrete bridge across the famous "Lost River." Here the tester took out cores from solid rock 23 ft. below the surface of the water.

Approximately six miles of finished concrete pavement laid this summer in three contract projects on the east end of the National road meet specifications of the state highway commission in every respect according to tests made by cores drilled in the pavement and subjected to laboratory analysis, John D. Williams, Indiana highway director, announces.

Cores removed from finished pavements by the driller are subjected to laboratory tests which removes any doubt as to the quality of pavement laid. Regardless of how smooth and pleasing to the eye a finished pavement may appear, there is always a chance that through error the slab is not laid to designated thickness. A test by the machine proves conclusively if the pavement is up to standard. This machine, highway officials say, will go further than any other equipment invented so far to prove to the public that state roads are built to plans and specifications.

A LARGER SIZE P. & H. CORDUROY EXCAVATOR CRANE

In 1920 the Pawling and Harnischfeger Co. built for the U. S. Reclamation Service a machine designed to have as large capacity as possible and at the same time designed so that it could be loaded upon a standard flat car without the machine proper being dismantled.

The demand for a larger size excavator designed to come within standard railway clearances without dismantling, has greatly increased and for this reason the P & H 208 machine is now being placed on the market as a part of the Standard P & H Line.

This machine will handle a 1-yard Page dragline bucket on a 35-ft. boom, a ¾ yd. Page bucket on a 40 ft. boom or a ½ yd. bucket on a 50 ft. boom. It will also handle clamshell buckets of from ½ to 1½ yds. capacity depending upon the material handled. With but a few unimportant changes the 208 can be converted into a powerful gas shovel handling a 1-yd. dipper. In addition to being used as a gas shovel or with clamshell and dragline buckets, the 208 machine can be used with backfilling scraper, crane hook or electric magnet.

The 208 is of rugged steel construction, of the full revolving type, and is one-man operated. Turned shafts, of forged alloy steel where necessary, are used. All gears are of steel with cut teeth. The corduroy tractions are of the P & H self-cleaning type having special high carbon cast steel treads and heat-treated alloy steel link pins. The corduroys are completely available for inspection and renewals with a minimum of jacking. The ground bearing pressure is about 10 lbs. per square inch.

By means of independent gear drives on each corduroy the following motions may be accomplished.

1. A high speed forward and reverse on both corduroys.

2. A low speed forward and reverse on both corduroys.

3. A high speed forward and reverse on one corduroy and a low speed forward and reverse on the other interchangeably.

4. A high or low speed forward and reverse on one corduroy with other corduroy running idle, interchangeably. All of these motions are controlled from the operator's platform regardless of the position of the revolving frame. The transmission gears move on spline shafts. The construction effectively prevents the gears from sticking.

A 7¼x9 75 H. P. heavy duty internal combustion motor running at 500 r. p. m. is gear connected to the jack shaft, the connecting gears running in an oil tight cast iron case. Outside band clutches of liberal design are used for connecting the engine to the jack shaft, and for the combined swinging and propelling shaft. Drums are mounted on separate shafts, the digging drum being provided with machine cut grooves.

The boom is hoisted and lowered by means of a drum operated by self-locking worm and worm gear enclosed and running in oil.

Operating levers are concentrated at the right front side of the machine giving the operator full view of the work. The machine is completely enclosed by a sheet steel housing.

VALUABLE TRADE LITERATURE

(Editor's Note—Copies of the trade publications here briefly reviewed may be obtained by writing to Municipal and County Engineering, or by writing direct to the addresses given in the reviews.)

Power Scrapers and Dragline Cableway Excavators.—Sauerman Power Scrapers and Sauerman Dragline Cableway Excavators are illustrated and described in pamphlets Nos. 16 and 17, respectively, recently issued by Sauerman Bros., 1142 Monadnock Block, Chicago, Ill. The range of adaptability of the line of bottomless power scrapers is clearly indicated with numerous illustrated examples. Some of the more important applications are: loading direct to cars and trucks through a trap; small gravel pit operations; large sand and gravel plant operations; removing overburden, making cuts and fills; and stock-piling and reclaiming loose materials. The treatment of the dragline cableway excavators is with special reference to the handling of sand and gravel in both large and small operations.

Activated Sludge Process of Sewage Treatment.—Illustrated descriptions of the activated sludge plants at Woodstock, Ontario, and Gastonia, North Carolina, have been published in a pamphlet by the General Filtration Co., Inc., Rochester, N. Y. Incidentally, it is interesting to note that such large cities as Chicago, Milwaukee, and Indianapolis, and such small cities as Mamaroneck, N. Y., and Graham, Texas, are now installing activated sludge plants.

Velocity Stage Turbines.—A line of velocity stage turbines especially designed for high pressure and high temperature steam is described in a 28-page catalog issued by the De Laval Steam Turbine Co., of Trenton, N. J. The cast steel steam chest is located in the casing cover in order to avoid the conduction of heat to the bearings. In addition to the speed governor and governor valve, there is an independent valve controlled by an automatic overspeed trip. The turbines are built in sizes up to 1,200 H. P., and are designed to be directly coupled to high speed centrifugal pumps and blowers, AC and DC generators, and by means of double helical speed reducing gears, to large pumps and blowers, medium size generators, belt pulleys, rope sheaves and slow and moderate speed machinery.

New Road Oiling Equipment.—A new road oiling machine, known as the Champion Pressure Heating Distributor for mounting on motor trucks, is illustrated and described in bulletin K. E. S., recently issued by the Good Roads Machinery Co., Inc., Kennett Square, Pa. This equipment is for use in applying road oils, tar products and dust-laying materials. This machine has been designed and perfected by engineers who have a practical knowledge of the proper application of bitum-

inous binders in quantities. It has been well tried out and has been uniformly successful.

Contractors' Type Scoop Conveyor.—Five thousand Scoop Conveyors have been sold in five years, designed primarily for handling coal. Realizing that upkeep costs, when handling such sharp and abrasive materials as crushed stone, sand and gravel, in a machine designed for handling coal, The Portable Machinery Co., Inc., Passaic, N. J., has perfected, and issued an illustrated bulletin on a contractors' type scoop conveyor. The bulletin shows the various applications of this new scoop conveyor on road and other construction work and gives its performance records. Extracts from users' letters are quoted.

Duplex Pumps.—A 68-page catalog (No. 107) on "Durable" Duplex Pumps for all purposes issued by Dean Bros. Steam Pump Works, Indianapolis, Ind.

Concrete Mixers.—"Smith Snapshots," Vol. 11, No. 1, the house organ of the T. L. Smith Co. of Milwaukee, is being distributed. It contains information and illustrated articles on Smith Pavers, Smith Tilting Mixers used in central mixing systems, and on water works construction, Smith 7-S and 4-S Mixers, and the Smith Excavator and Loader.

Ratchet Pipe Cutters.—A pamphlet on the money-saving possibilities of the Strickler line of ratchet pipe cutters, issued by W. W. Strickler & Bros. 380 Hamilton Ave., Columbus, Ohio. Eight sizes of cutters for cutting any size of cast iron, steel or wrought pipe by hand, are illustrated.

Excavating Equipment.—Bulletin 57-X just published by the Pawling & Harnischfeger Co., of Milwaukee, describes and illustrates in its 36-pages P & H Gas Driven "8 in 1" Excavators of various sizes and types including full circle swing gas shovels, draglines, grab bucket cranes, material handling cranes, and the other rigs to be used with this machine, as the skimmer scoop and pile-driving rig, and such accessories as may be used with these cranes as the backfilling scraper bucket, hook and sling chains, and electro magnet. This Bulletin supersedes No. 56-X with additional information on the 208 and 210 Excavators. These larger machines are also mounted on the P & H Corduroy Traction which has given rise to the slogan, "Follow the Corduroy Trail—the Tread Mark of P & H Equipment."

Paving Mixers.—"Smith Pavers" is the title of a new 32-page catalog recently published by The T. L. Smith Co., of Milwaukee. This catalog contains many illustrations and the latest information on Smith Paving Mixers, which are built in sizes 10-E, 14-E and 21-E. Among the new developments mentioned are the full caterpillar type traction machines, which are being manufactured in the two larger sizes. These sizes may still be equipped with half caterpillar traction, when desired, while the 10-E size, used largely on street and alley work, is provided with wheel traction as formerly. The particular features of the new Smith full caterpillar traction unit which are of interest to contractors are described in detail. Another Smith feature that is brought out in the catalog is the small number of operating controls. These, in conjunction with the automatic operations, so it is claimed, make one-man operation a practical reality.

Scoop Truck Bodies.—The Eastern Scoop Body for Ford Trucks is described and illustrated in Bulletin 32 issued by the Easton Car and Construction Co., 50 Church St., New York, N. Y.

Hydrogen-Ion Outfit.—The La Motte Hydrogen-Ion Comparator Set is described in a pamphlet issued by the La Motte Chemical Products Co., 13 W. Saratoga St., Baltimore, Md.

Road Graders.—A folder on the use of Adams Adjustable Leaning Wheel Graders, and which explains the leaning wheel principle involved, was issued recently by J. D. Adams & Co., Indianapolis, Ind. It is claimed that the adjustable leaning wheel feature, which is an exclusive feature on Adams Graders, enables the operator to hold the machine wherever he wants to work it and to move a capacity load without skidding, or waste of power.

Compressed Air Tools.—A few suggestions on the use of compressed air tools, with a general idea of the saving possible as compared with hand methods, are given in a folder issued by The Ingersoll Rand Co., 11 Broadway, New York, N. Y. The development of the Portable Compressor has made it possible to secure compressed air when and where it is wanted. The folder refers especially to small or "short time" jobs.

Integral Waterproofing.—The Science and Practice of Integral Waterproofing is the title of a 32-page booklet issued by the Truscon Laboratories of Detroit, Mich. It describes the process as applied to basements, cement, stucco, reservoirs, cisterns, tunnels, standpipes, foundations, subways and masonry structures of all kinds.

Steel Forms.—The most complete catalog on steel forms for use in street and highway construction ever issued is catalog No. 28 recently issued by the Heltzel Steel Form and Iron Co., of Warren, O. In addition to featuring steel forms, this 24-page catalog illustrates the Universal Tamping and Finishing Machine and describes a new method of building culverts by the use of the same steel road forms used on general road construction.

Asphalt Booklets.—Simple, comprehensive, well-illustrated booklets on the different types of asphalt pavement construction including Sheet Asphalt, Asphaltic Concrete, Asphalt Macadam, Asphalt Filler, Asphalt to Resurface Worn Brick, and Asphaltic Road Oil, have been prepared by The Texas Company, Asphalt Sales Department. "What is Your Highway Problem?" is the name of a portfolio issued by this company which gives a brief resume of the facts of each highway construction use to which asphalt is put. Anyone desiring any of the above booklets may very readily procure them by addressing a brief request to The Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Powdered Fuel Equipment.—This is the first general catalog pertaining to Grindle Powdered Fuel Equipment. It contains 40 pages of text and illustrations. It makes plain the advantages of powdered fuel in general and also the special advantages of the Grindle System. This catalog will be supplemented by bulletins from time to time describing the application of Grindle equipment to various classes of work. A copy of the catalog may be obtained from the Grindle Fuel Equipment Co., Harvey, Ill.

Drinking Fountains.—A folder on drinking fountains for public streets, parks, playgrounds and school yards, issued by The Murdock Mfg. and Supply Co., Cincinnati, Ohio. Pertains to the Murdock anti-freezing bubble font which is especially designed for outdoor installation.

Oil Burning Appliances.—Bulletin No. 20, issued by Aeroil Burner Co., Inc., 266 Hudson Ave., Union Hill, N. J., illustrates and describes appliances for roofers, waterproofers, paving contractors, insulating contractors, railroads, roadbuilders and street and highway departments.

Architects Specification Handbook.—An 8½x11 in., 108 pages, loose leaf handbook issued by The Truscon Laboratories, Caniff and Grand Trunk Ry., Detroit, Mich. The principal contents pertain to: Waterproofing, Damp-proofing, Oilproofing, Technical Finishes, Chemical and Metallic Floor Hardeners, Protective Steel Coatings, and Architectural Varnishes.

Hug Turntable and Hug Subgrading Machine.—These two machines, designed and constructed by a successful road builder, The Hug Co., of Highland, Ill., are illustrated and described in a 4-page pamphlet. It is claimed that the subgrader will save the labor of 10 men a day and that it will also save concrete, on road construction. It trims the subgrade true to grade. The cutting depth is adjustable. It is equipped with special crank axle and wheels, providing easy transportation. The turntable will turn a loaded truck on the truck's own power. It protects the finished subgrade. It does not require a track. It occupies only 7½ ft. width on the road and can be moved by two men. It speeds up the job and fewer trucks are required with it than without it.

Continuous Roofing Kettle.—The Iroquois Continuous Roofing Kettle, manufactured by the Barber Asphalt Co., Land Title Bldg., Philadelphia, Pa., is illustrated and described in a four-page pamphlet. It is claimed that revolutionary ideas are embodied in this kettle and that roofers and other users of asphalt melting kettles can derive economies from it.

Concrete Mixers.—Catalogs illustrating and describing their lines of Builders' Mixers and Boss Heavy Duty Type Mixers have been issued by the American Cement Machine Co., Inc., Keokuk, Iowa.

LOCK BAR PIPE

An agreement has recently been reached between the East Jersey Pipe Co. and the Riter-Conley Co., whereby "Lock Bar" Steel Pipe, which has been exclusively controlled by the East Jersey Pipe Co. since its introduction into this country in 1905, and has been hitherto manufactured by the East Jersey Pipe Co. at its plant at Paterson, N. J., will be hereafter fabricated in the Pittsburgh district by the Riter-Conley Co. at its Leetsdale plant. This is regarded as a step forward by both parties as it will permit considerable saving in freight rates and economy in manufacturing. "Lock Bar" Pipe has enjoyed a consistently increasing demand as a carrier for both water and gas, and the entire water supply of many a city in this country and Canada is dependent upon its "100 per cent joint." The sale of "Lock Bar" Steel Pipe will continue to be exclusively in the hands of the East Jersey Pipe Co.

$190,000,000 FEDERAL AUTHORIZATION AIDS ROAD CONSTRUCTION

Federal aid for road construction will be continued as a result of the authorization of additional appropriations for this work amounting to $190,000,000 carried by the Post Office appropriation bill signed by President Harding June 19, 1922. Fifty million dollars is authorized for the fiscal year beginning July 1, this year, and $65,000,000 and $75,000,000, respectively, are authorized for each of the two succeeding fiscal years. In addition, $6,500,000 is authorized for forest roads for each of the two fiscal years beginning July 1, 1923, and July 1, 1924. The funds will be administered by the Secretary of Agriculture through the Bureau of Public Roads.

The apportionment to be made to the various States is approximately as follows:

Fiscal Year Ending 1923.	
Alabama	$ 1,035,614
Arizona	702,188
Arkansas	836,095
California	1,641,399
Colorado	894,117
Connecticut	320,599
Delaware	243,750
Florida	591,217
Georgia	1,331,972
Idaho	625,691
Illinois	2,164,187
Indiana	1,305,904
Iowa	1,401,915
Kansas	1,401,521
Kentucky	944,786
Louisiana	664,660
Maine	463,440
Maryland	427,086
Massachusetts	730,784
Michigan	1,499,688
Minnesota	1,415,731
Mississippi	863,271
Missouri	1,632,086
Montana	1,031,257
Nebraska	1,054,126
Nevada	635,624
New Hampshire	243,750
New Jersey	628,581
New Mexico	793,216
New York	2,464,299
North Carolina	1,139,556
North Dakota	776,476
Ohio	1,882,003
Oklahoma	1,168,226
Oregon	788,443
Pennsylvania	2,265,969
Rhode Island	243,750
South Carolina	707,492
South Dakota	802,707
Tennessee	1,098,461
Texas	2,950,115
Utah	566,278
Vermont	243,750
Virginia	971,219
Washington	735,806
West Virginia	534,906
Wisconsin	1,263,211
Wyoming	623,078
Total	$48,750,000

These funds must be matched by the States and will be administered subject to the general provisions already in force.

Features of New Legislation

The new legislation reduces the maximum participation on the part of the Government from $20,000 to $16,250 per mile for roads constructed with the appropriation for the next fiscal year and $15,000 per mile thereafter. Bridges over 20 ft. in span may be considered as separate projects to which this limitation does not apply. In States where more than 5 per cent of the area is unappropriated public land provision is made for an increase in the amount per mile. The act also provides for the extension of Federal aid to the construction of structures required for the elimination of railroad grade crossings.

Important provisons of previous acts under which large funds have been successfully administered are applicable to the new funds. States must maintain adequate highway departments. Funds to match Federal aid must be placed under the direct control of the State highway department. The type of surface constructed must be adequate for the traffic anticipated, with reasonable grades, curves and other features. States must obligate themselves to maintain all Federal-aid roads constructed, and in case this is not done any Federal funds available for new projects may be withheld until they are put into satisfactory condition. All Federal-aid funds must be spent on a connected system of roads consisting of not more than 7 per cent of the total mileage in each State and divided into primary or interstate roads and secondary or intercounty roads.

Plans Received from All but Eight States

Plans for the proposed system have been received by the Bureau of Public Roads from all but 8 States, and the State systems are being coordinated so that when joined together they will serve the best interests of the whole country. In the meantime only projects certain to be on the proposed system are being approved.

The new apropriation comes at a time when several States are nearing the limit of funds available. The authorization of funds for three years in advance will be of great benefit to all States in that it will permit them to lay their plans for some time ahead. Uncertainty as to future Federal aid is removed and provision can be made at once for raising State funds to match it.

What the new funds will mean to the country can be judged by the use that has been made of the $350,000,000 previously appropriated. On May 31, 17,000 miles of road had been completed, and, in addition nearly 14,500 miles were

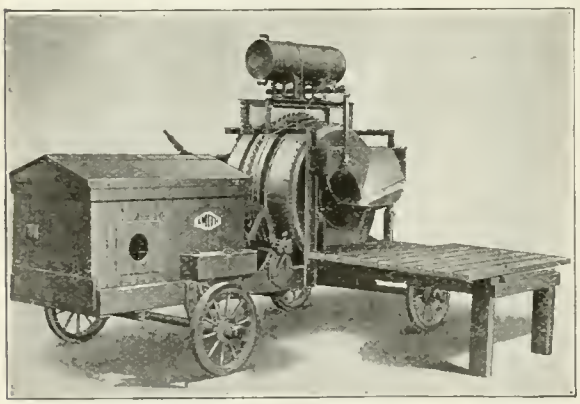
under construction. Federal-aid roads in all stages total nearly 38,7000 miles, involving over $287,500,000 of Federal aid. To match this fund, the States have appropriated approximately $380,000,000, making a total of $667,500,000.

All types of road have been constructed with Federal aid to meet the varying conditions in the United States. The average cost per mile has been $17,120, and Federal aid has amounted to 43 per cent of the total cost.

It is estimated that the $190,000,000 lately authorized will result in the construction of more than 25,000 miles, which added to the 46,000 miles that is expected to result from previous appropriations makes a total of 71,000 miles, or nearly 40 per cent of the estimated 180,000 miles of road in the system of Federal-aid roads now being outlined.

CONCRETE MIXERS WITH RUBBER TIRES

Smith 7-S Mixers, made by the T. L. Smith Company of Milwaukee, are now being furnished with rubber tires when desired. The fact that this type and size of mixer is used to such a great extent for city and town concrete jobs such as building foundations, curbs, culverts, bridge approaches, etc., requires considerable transportation from one location to another. The rubber tires make the transportation easier and quicker besides saving unnecessary jarring of the mixer.



SMITH 7-S (one bag) MIXER WITH RUBBER-TIRED WHEELS.

BIG ROAD PROGRAM IN TENNESSEE

The State of Tennessee has inaugurated a new Federal aid road building program involving the expenditure of $8,000,000 for 281 miles of roads in 20 counties. While this program is being carried out a campaign is under way to increase the State Highway Fund by means of a gasoline tax and a bond issue. This movement has the support of the automobile clubs of the state and the Tennessee Good Roads Association. The highway department of the State recently let contracts for 138.86 miles of bituminous macadam roads in the vicinity of Altamont, Ashland City, Elizabeth, Erwin, Greenville, Huntington, Kingston and Dandridge, the cost of which will be $4,884,500.

CALIFORNIA IMPROVES THE SURFACES OF ITS ROADS

The California State Highway Department has begun a systematic widening of state highways in many parts of the State and has adopted the Maryland policy of surfacing some of its concrete roads with asphalt. California has also begun work on a considerable mileage of bituminous macadam. In Glenn County 3½ miles of road will be of bituminous macadam, 5 ins. thick and 20 ft. wide. Five miles of concrete road in Placer County will be surfaced with 3 ins. of asphalt. The same treatment will be accorded three miles between Fairfield and Vacaville, in Solano County. In Sonoma County, 3 miles north and 1¼ miles south from the Petaluma city limits, a total distance of 4½ miles of concrete road will be widened to 20 ft. and surfaced with asphalt. Four and one-half miles of concrete road in Santa Clara County, near Carnadero, will also be surfaced with asphalt. Similar treatment will be given 16 miles of concrete roads in Merced, Madera and Kern counties.

Contracts Awarded

ROADS AND STREETS

Cal., Newport Beach—Independent Asphalt Paving Co., Seaboard Bldg., Seattle, Wn., awarded contract for paving Central Ave. and other streets, at $459,960.

Cal., Oxnard—Southwest Paving Co., 415 Washington Bldg., Los Angeles, awarded contract for paving various streets here, at $128,363.

Cal., Sacramento—Kaiser Paving Co., Oakland, awarded contract for paving with bituminized macadam 17.18 mi. state hwy. Kern Co. bet. Junction Pumping Station and Hart, at $380,322; Nevada Contr. Co., Fallon, Nev., awarded contract for grading 5.8 mi. state hwy. in Tulare Co. bet. Three Rivers and Sequoia Nat. Pk. at $121,173.

Cal., Sacramento—Pacific Constr. Co., Oakland, awarded contract for an 8-mile stretch from westerly boundary to San Luis Creek at $125,580; Blanco & Taylor, Vallejo, awarded contr. for 13 miles from the creek to Los Banos, at $216,550.

Cal., Woodland—A. Teichert & Son, Sacramento, awarded contr. by Yolo Bd. of Supvrs. for constr. of 4 mi. improved hwy. bet. bypass and Waldek's barn along Sacramento river; also for rd. impvt. in Washington, at $112,000. River road contr. calls for aspg. surf. and amounts to $112,000.

Fla., Ocala—Barber, Fortin Co., Warren, Ohio, awarded contr. by Marion Co. Commrs. for paving 20 miles State Rd., 2—Belleview to Lake County line; lime rock compacted, at $164,090.

Fla., Orlando—Following contracts let by Orange Co. Commrs: grading East Coast Rd. from Bithlo to Brevard Co. line, to E. W. Barker, Tampa, at $63,400; extending Oakland-Winter Garden Rd. to Lasley Bros. and Harvey of Chattanooga at $320,000 for 16-ft. brk. hwy.; W. P. McDonald Constr. Co., for constructing asph. road near Windermere, at $121,560.

Fla., St. Augustine—Jas. V. Wilson Co., awarded contract (tentative) by Co. Commrs. for constr. of upwards of 50 mi. hard surf. roads in St. Johns Co., contingent on bonds being voted by the people. Contr. price is $456,472.

Fla., St. Petersburg—Georgia Engineering Co., awarded contract of 3.840 ft. vitr. brk. paving at $306,652.

Fla., Starke—Barber Fortin Co., Gainesville, awarded contr. for hard surfacing Marion County's part of road No. 2 from Belleview to Lake Co. line, (16 miles) at $165,000.

Ida., Boise—Morrison & Knudson, Boise, awarded contract for 21 miles bet. Tamarack and Round Valley, Adams Co., at $134,972.

FOR SALE

Best 60 H.P. Track-laying tractor, overhauled, repainted, practically as good as new. Immediate delivery. For price and special terms, address

H. W. Chown,
305 Merchants Bank Bldg.,
Indianapolis, Ind.

Ida., Nampa—Jack McGuire, Idaho Falls, awarded contract for paving 31 blocks city streets with bithu lithic paving, at $157,410.

Ill., Springfield—Capital Constr. Co., Des Moines, Ia., awarded contract for 6 miles paving in Henry Co., at $125,199; J. E. Crane, Murphysboro, awarded contract for 4.8 mi. Route 2, Sec. 12; also 8.6 mi. Sec. 13, at $396,732; M. Haynes & Son, Janesville, Wis., awarded contract for 6.47 mi. on Route 2, Sec. 4, Union-Pulaski Cos., at $115,928; 3.67 mi. on Sec. 15 in Pulaski Co., at $66,712, and 6.95 mi. on Sec. 16 in Pulaski Co., at $137,901.

Ia., West Union—A. Carlson, Marshalltown, awarded contract for paving, curbing and guttering, at $122,796.

Ky., Frankfort—Following contracts let for road impvts.: Harlan-Pineville Rd., Harlan Co. to Dempster Constr. Co., at $93,918; Geo. M. Eady Co., Louisville, Ky., for Glasgow-South Rd., at $189,079; Costello Bros. Co., Knoxville, Tenn., contr. for Caldwell Co., Princeton-Marion Rd., at $57,211; Grayson-Olive Hill Rd., (2 brdg. approaches to Thomas Co. on Barrett's Creek only, at $17,780; Hopkinsville-Elkton Rd., Christian Co. to N. E. Stone Co., Madisonville, Ky., at $37,450; Estill Co., Irvine-Richmond Rd., macadam to Connelly Const. Co., Somerset, Ky., at $69,841 and surf. treatment to R. B. Taylor Co., Louisville, at $3,910; Henderson Co.-Louisville-Paducah Rd. to Taylor-Petrie & Co., Lewisport, Ky., at $14,457; Laurel Co., London-Mt. Vernon Rd., to Vermillion Constr. Co., Barbourville Ky., at $20,410; Rowan Co.., Morehead-Grayson Rd., at $70,695. Surface treatment awards as follows: Bell Co., to Southern Oil & Tar Co., Louisville, at $9,361; Bourbon Co., R. B. Tyler Co., Louisville, $6,432; Jefferson Co., Southern Oil & Tar Co., Louisville, $10,666; Nicholas Co., R. B. Tyler Co., $7,228; Shelby Co., R. B. Tyler Co., $2,850; Todd Co., R. B. Tyler Co. No. 3215; Cumberland Co., Alexander & Beck, Marrowbone, Ky., $16,780.

Mass., Boston—J. E. Watkins, Amesbury, awarded contract by State Hwy. Dept. for road work in Middleton, at $29,397; Lane Constr. Co., Meriden, Conn., awarde contr. for Dalton & Windsor rd. work, at $161,958.

Mass., Boston—State Hwy. Dept. let following

It "Stays Put"

The Non-Skid Ink Stand

(and Paper Weight)

is of particular value to drawing ink users who work on a slanting drawing board.

It will not slide unless the board is inclined to an angle of more than 27½ degrees.

A cork insert at bottom does the trick, and make it "stay put."

PRICE, 35c, POSTPAID

$3.50 Per Dozen.

KOLESCH & CO.

138 Fulton Street New York

K TRADE MARK

ontracts: M. McDonough, Swampscott, awarded ontr. for constr. of 3,260 ft. state hwy., in Andver; granite blk. and rein. conc., at $108,511; J. T. uinn, Ashton, R. 1., 23,354 ft. Mohawk Trail, oute, Shelburne, bitum. mac. at $219,349; Hoyt onstr. Co., 85 Dartmouth St., Holyoke, awarded ontract for 17,550 ft. bitum. macadam hwy., Wilamstown and New Ashford, 18 ft. at $127,604.

Mich., Lansing—Following road impvt. contracts t; Rd. No. 37-6, Kent Co., Caledonia Twp. C1 rein. conc. 18 and 20 ft. 2.688 mi. to A. E. Green, rand Rapids, at $48,991; No. 21-17, Lapeer Co. nlay Twp. C1 F rein. conc. 18 ft., 2.332 ml. to . D. Brooks, Omer, Mich., at $44,177; Rd. 24-20, Iecosta Co., Norton Twp. C1 B gravel, 16 ft. 022 mi. to Wilson Luxom, Lakeview, Mich., at 9,799; No. 86-1, Mecosta Co. Millbrook Twp. C1. ; gravel, 16 ft. 5.983 mi. to Whitney Const. Co., rand Rapids, at $49,328; Rd. 14-26 Jackson Co., ummit Twp. C1. B gravel, 16 ft. 2.932 mi. to Townend-Shuttleworth-Ballmer Co., Lansing, Mich., at 21,184; Rd. 19-12, Sanilac Co., Speaker Twp., C1. ; gravel, 16 ft. 5.886 mi. to Moore-Elmer Constr. o., Snover, Mich., at $58,985; No. 14-15, Benzie o., Joyfield Twp. C1. B gravel, 16 ft. 1.005 mi. o Regan-Baker Co., Kewadin, Mich., at $7,915.

Minn., Winnebago—Following contracts let for aving and curbinb in various districts: (1) Grading and paving to Hanlon & Oakes, 338 Lmbr. Exch., Minneapolis, asph. conc. Cl. C, at $100, 42; Main St. Dist. Grading 2,275 cu. yds., Paving, 5,004 sq. yds.; W. Cleveland St. Dist., grading 426 cu. yds. Paving, 11,376 sq. yds., Cleveland St. Dist. Grading 2500 cu. yds. paving, 8080 sq. rds. (2) Curbs, Simeonson & Larson, $14,135.

Miss., Bay Springs—Myers Constr. Co., Hattiesburg, Miss., awarded contract for 14.3 miles gravel surfaced road bet. Meridian and Hattiesburg, at $140,000.

Nev., Carson City—Phelps Constr. Co., Salt Lake City, awarded contract at $110,126 for constr. of Rte 1, Sec. B, 19.83 mi. Elko Co., at $110,126; J. H. Causton, Lovelock, Nev., contract for Rte. 2, Sec. C-2, 15.01 mi. in White Pine Co. bet. Ellipah and Robinson's Summit, at $93,027; Nevada Contracting Co., Fallon, Nev., awarded contract for constr. of Rte. 2, Sec. B, 22.95 mi. in White Pine Co. at $174,778.

N. J., Camden—Corson & Sutton. Ocean City, awarded contract for paving Landis Ave. at $254,000.

N. Y., Albany—Neilan Brothers, Tonawanda, awarded contract for impvt. of Fredonia-Silver Crk. rd., parts 3-A and 3-B, at $146,165.

N. Y., LaSalle—F. J. Mumm Constr. Co., Buffalo, awarded contract for paving with conc., 2 miles section of Military Rd., at $48,546; Walter C. Rich, Youngstown, awarded contract for constr. of improved river road bet. Niagara Falls and No. Tonawanda—approx. 5½ miles at $226,900. German Rock Asphalt Co., Buffalo, will in all probability, be given contract for International Railway Company's share of the River Rd. paving, which includes strip 19 ft. wide along side and het. tracks from Niagara Falls city line east to present Cayuga Crk. brdg.

N. Y., Niagara Falls—Following is City Manager's report approved by Council: That contract for paving 18th St., be awarded to Read-Coddington Engrg. Co. at $47,528 for sheet asph.; contr. for paving Falls St. to same company at $75,999 for sheet asph. pavement; contr. for paving Ferry Ave. to same company at $47,923 for sheet asph. pavement; contr. for paving Mackenna Ave. to J. F. McKinney Corp. at $17,588 for 3-in. vert. fibre brk. pavement; contr. for paving LaSalle Ave. to same corporation, at $19,279 for 3-in. vert. fibre brk. pavement.

N. Y., Yonkers—The Jas. J. Hart Constr. Co., City, awarded 3 contracts by State: 1 contract for paving state roads within village of Port Chester, at $155,000; the other two for constr. of brdg. over Byram River at $5,700 and for constr. of sewer along thorofare in Pt. Chester that Is to be paved, at $17,000.

N. C., Asheville—Asheville Paving Co., awarded contract to pave Southside Ave. with 7-in. conc. base and Biltmore Ave. with 6-in. conc. base at $125,000.

N. C., Raleigh—State Hwy. Comn. let following contracts for road work No. 110—Pasquotank Co. 2.71 mi. hard surf. road betw. Elizabeth City and Camden Co. line, to J. L. Gehee, at $117,364; structs. to G. E. Ward at $18,626; 340—Cumberland Co., 11.07 mi. hard surf. rd. bet. Fayetteville and Hoke Co. line to Alabama Conc. Products Co., at $334,714; structs. to Hobbs-Peabody Constr. Co. at $11,004; 312—Brunswick Co., 9.77 mi. hard surf. rd. from Leland to Columbus Co. line to Alabama Conc. Products Co. at $302,834; structs. to Batson-Cook Co., at $14,372; 316—Brunswick Co. 12.12 mi. gravel rd. on Wilmington-Charlotte-Asheville Rd. to B. F. Price, at $45,115; structs. to Batson-Cook Co. at $25,133; 364-B, Onslaw Co., 12.84 mi. gravel rd. betw. Dixon and Jacksonville to A. W. McClay, at $49,452 and for structs., at $40,432; 502—Alamance Co., 17.43 mi. gravel rd. bet. Graham and Randolph Cos. to W. N. Thompson, at $67,939; structs. to Hanford Bros., at $62,078; No. 545, Hoke Co., 9.20 mi. gravel rd. bet. Raeford and Scotland Co. line to A. W. McClay at $35,347; structs., at $16,281; No. 593—Rockingham Co., 17.60 mi. hard surf. rd. bet. Reidsville and Va. State line to J. A. Krees, at $447,630; 614—Cabarrus Co., 9.20 mi. hard surf. rd. from Concord to Mecklenburg Co. line, to G. L. Harris, at $280,845; structs. to Oliver-Costello Bros., at $37,703; 670—Cabarrus-Rowan Cos., 4.53 mi. hard surf. rd. from Kannapolis to Luther's Church, to Southern Constr. Co., at $128,642; 741—Forsyth Co., 8.90 mi. hard surf. rd. bet. Hanes and Davie Co. line, to Hardaway Constr. Co., at $265,041; structs. to Mills-Williams Constr. Co., at $21,030; 742—Forsyth Co., 10.62 mi. hard surface rd. on Boone trail from Winston-Salem to Yadkin River to A. J. Wardrup, at $384,399; structs. to Stearnes Bros., at $15,136; 888 Yancey Co., 15.22 mi. hard surf. rd. from Swiss to So. Toe River, to R. S. Freeman, at $97,970; structs. at $42,933; 913—Cherokee Co., 10.33 mi. waterbound macadam rd. to Mills-Williams Constr. Co., at $86,868; 953—Jackson Co., 12.772 mi. grade and construct bridges from Dillsboro to Macon Co. line, to C. C. McCabe, at $87,715; structs. to A. E. Wilson, $17,997; 954—Jackson Co. 1.68 mi. hard surf. rd. bet. Sylva and Dillsboro to Mills-Williams Constr. Co. at $66,764; structs. at $15,676.

N. C., Rockingham—Hedrick Constr. Co., Burlington, awarded contr. for paving various streets with sheet asph.-on 5-in. conc., at $160,229; Slattery & Henry, Greenville, awarded contract by Sumter Co., Sumter, S. C., for paving 3.64 miles Stateburg Rd. with asph. at $100,000; Powell Paving Co., Centerville. contr. for asph. surfacing 6½ mi. Pinewood & Camden Rds. at $150,000.
Rd. to Westrick, Krauss & Shreves, Napoleon, at

O., Columbus—Following contracts awarded by Director of Hwys.: 3 mi. brk. on Lima-Sandusky $97,132; Auglaise Co. 6½ mi. macadam on Lima-Wapakoneta Rd. to H. E. Pratt Co., Mt. Blanchard, at $147,528; also 5 mi. brk. on Sidney-Wapakoneta Rd. to Radebaugh-Graham Co., Columbus, at $191,161; Carroll Co. 3 mi. brk. on Minerva-Sandyville Rd. to Chester General Contg. Co., E. Liverpool, at $87,719; also 2½ mi. brk. on Carroll-Malvern Rd. to same company at $100,150 and 4 mi. brk. on Carrollton-Malvern Rd. at $157,425; Coshocton Co. 3 mi. brk. on Newark-Coshocton Rd. to V. C. Smith, Dayton, at $125,610; Hancock Co. 2 mi. conc. on waterbound base on Findlay-Kenton Rd. to H. E. Pratt Co., Mt. Blanchard, Medina Co. 2½ mi. conc. on Ashland-Medina Rd. to Crum & Woods, Lodi, at $77,931; Morgan Co., 2 mi. macadam on Malto-Glouchester Rd. to Miller & Rothrock, Ada, at $48,804; Perry Co. 3 mi. conc. on Zanesville-New Lexington Rd. to Newark Paving & Constr. Co., at $102,144; Sandusky Co., 3 mi. brk. on Fremont-Oak Harbor Rd. to Modern Constr. Co., Fremont, at $114,755; Seneca Co. 1½ mi. macadam on Columbus-Sandusky Rd. to Central Paving Co., Hamilton, at $28,477; Union Co. 4 mi. macadam on Marysville-Marion Rd. to L. G. Rockholt, West Mansfield at $99,827; Wayne Co. 2 mi. brk. on Akron-Wooster Rd. to Harry Gilbert, Akron. at $56,115; also 3 mi. conc. on Orrville-Northern Rd. to E. M. Shaffrey Co., Akron, at $105,606.

Okla., Oklahoma City—Beekman Constr. Co., awarded contract for paving Edmond Rd., 6½ miles. Bid for 6 miles of the work was $237,000 and this was reduced on a pro rata basis to cover the 4½ mi. Road will be built with 5-in. conc. base and 3-in. vert. fibre brk. surface.

R. I., Providence—T. J. Quinn & Sons, Ashton, awarded contract to constrnct 20,000 ft. state hwy. on stretch known as Cummington and Goshen Rd.

no. of Shelburne Falls, Mass., to T. J. Quinn & Sons, at $221,051.

S. C., Charleston—J. M. Gregory & Co. awarded contract for constr. of conc. hwys. in St. Andrews Parish from 8-mi. post to John's Isl. crossing and exten. of Meeting St. Rd. to the Blue House rd., at $33,000; contr. to same contractor for exten. of project in St. Andrews Parish at $158,282.

Tenn., Nashville—Boyd Williams, Murfreesboro, awarded contract for bldg. 6.61 miles bitum. macadam rd. Cannon Co., at $160,903. 8-in. hand-placed base course will be used; bridges of more than 20-ft. span, awarded to J. B. Ramsey, Fayetteville, at $73,743; 8.91 mi. rd. Bledsoe Co., awarded to R. S. Freeman & Co., Knoxville, at $240,621; bridge, to Luten Bridge Co., Knoxville, at $14,721.

Tex., Breckenridge—Womack Constr. Co., Dallas, awarded contract for paving at $303,595. All the main streets in city will be paved.

Tex., Dallas—Scarborough & Davis, awarded contr. for construction of Seagoville Rd. at $164,-938. Company will pave entire distance of 18 miles with exception of small strip in White Rock bottom which will be paved with conc. and which will be let as separate contract.

Tex., McKinney—Tibbets Constr. Co., Ft. Worth, awarded contr. for road constr. work on the Five A Hwy. thru Collin Co., at $385,000.

Utah, Provo—Reed & Gibbons, Salt Lake City, awarded contr. for paving 6.6 mi. rd. from Spanish Fork to Payson via Banjamin, at $150,000. Paving will be a 4½-in. black base with 1½-in. bitulithic top.

Va., Big Stone Gap—Flenniken Constr. Co., awarded contr. for abt. $100,000 street paving here. Contr. includes grading, macad. base and asph. surfacing on abt. 2½ miles of streets. Contractors are located at Knoxville, Tenn.

Va., Woodstock—J. E. Lane & Co., Altavista, Va., awarded contr. by State Hwy. Comn., for constr. of Little River Turnpike betw. Alexandria and Fairfax, C. H., 11 1-3 miles, at $324,000.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Dinuba—Federal Constr. Co., Call Bldg., San Francisco, award. contract for constr. of sewage disposal plant, at $134,900. Former contract rescinded.

Ont., Hamilton—Contract for constr. of pipe sewers in King William, Stirton, Dalhousie and Gore Sts., also Campbell Ave., awarded to Jno. Maguire Contracting Co., Ltd., Toronto, at $187,433.

Ga., Atlanta—McDougald Constr. Co. awarded contract for sewer work at $124,650 (exten. of Lloyd St. sewer; at $11,907 to J. B. McCrary Co. for Stewart Ave. trunk sewer exten.; at $27,182 to Dysard Constr. Co. for constr. of small lat. sewers.

Kans., Clay Center—Reed & Whitlock, Clay Center, awarded contract for installation of sewer and other municipal work at Sharon Sprgs., Kans., Wallace Co., at $50,000.

Md., Baltimore—Wash. Suburban San. Comn., Wash., D. C., let contract for sewer and water constr. in Maryland as follows: Sewerage in Brentwood Cottage City and nearby territory, Prince George Co., at $54,573; Riverdale, at $41,834 to E. C. Baker, Uniontown, Pa.; water mains for sect. 3 and Martin's Addn. to Chevy Chase and Woodmont, at $73,765, to Phillip A. Grieves, New York; also contr. at $9,128 for water mains from Takoma Pk. filter plant to connect with main being laid from Silver Sprgs. toward Chevy Chase, etc.

Md., Hagerstown—Harry Angle, Hagerstown, awarded contract to construct sewerage system at $117,930.

River Rouge, Mich.—H. W. Watts, River Rouge, awarded contract for 7,000 ft. trunk sewer in Jefferson and Stoner Aves., 3-6 ft. diam. at $100,000.

Springwell, Mich.—Cooper-Widemann Constr. Co., 1430 Penobscot Bldg., Detroit, awarded contract for sewage treat. plant, Sec. 7, at $238,500.

N. Y., Long Isl. City—J. A. Gross, 8518 Fulton St., Woodhaven, awarded contract for sewers in Kingsland Ave. at $7,650; stormwater sewer in Borden Ave., to J. Gallo, 203 Division St., Brooklyn, at $75,386.

N. J., Clifton—Frank B. Beasman Co., Baltimore, Md., awarded contract for sanitary sewer system here, at approx. $750,000. Total cost of sewer work will be one million dollars.

N. M., Lordsburg—Jack Heather, local, awarded contract for constr. of sewer and water systems here, at $68,556.

N. Y., Canandaigua—Rochester Vulcanite Pavement Co., Rochester, awarded contract for sewage disposal plant and sewers, at $75,930.

N. Y., Mamaroneck—Francis Donaldson, New York, awarded contracts for disposal works; S. Wardell & Co., Stamford, Ct. contract No. 2, outfall extensions; Louis Petrossi & Co., Hartford, Conn., Contr. No. 3, sewers, at $116,955, $89,253, $72,427, respectively.

O., Akron—A. W. Morette, 23 E. Exchange St., awarded contract for 3430 ft. 30-72 in. brk. and 7,000 lin. ft. 6-24 in. vit. clay sewer in Wolf Ledge Run Sewer Dist., at $58,657.

Okla., Henryetta—City let following contracts for impvts. to sewer system: $26,700 to I. E. Hanson, Ada, Okla., furnishing material and installing san. sewer system; at $72,000 to Park & Horan, Okmulgee, Okla., for material, consisting of segment sewer blocks for installation of storm sewer mains; at $41,900 to Morkle Machinery & Contg. Co., Kansas City, Mo., to install sewage disposal plant.

Okla., Okla. City—Municipal Excavator Co. awarded contract at $115,035; White & Evans, contr. for First St. main sewer at $10,338.

Va., Richmond—Contract for sewers in Grace St., 9th to 1st Sts., including 1660 lin. ft. 30-36 in. segment blk. and 768 lin. ft. 15--24 in. terra cotta pipe, to Wingo & Deaner, P. O. Box 816, at $36,271; Main St., 8th to 13th Sts., 1586 lin. ft. 30-42 in. segment blk. to Kelly & McLane, 800 W. Cary St., at $40,452; 9th St., Main to Grace Sts., and Franklin St., 7th to 9th Sts., 1362 lin. ft. 24-30 in. segment to A. J. Boyle, 102 Wetmore Ave., Baltimore, Md., at $24,544.

WATER SUPPLY AND PURIFICATION.

B. C., Sumas—Dominion Engrg. Works, Montreal, Que., awarded contract for complete pumping plant for Sumas Dyking Comn., Kilgard, D. C., at $115,000.

Conn., Kensington—J. E. Driscoll, 499 Prospect St., Torrington, awarded contract for extending water supply sys.; castings, pipes, etc., to U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.; fittings, etc., to Builders iron Fdry., 9 Codding St., Providence, R. I.; valves, etc., to Ludlow Valve Co., Troy, N. Y.; hydrants, etc., to A. P. Smith Mfg. Co., East Orange, N. J. Total, $100,000.

Ct., Stamford—H. Steers Corp., 17 Battery Pl., New York, award. contract for constr. of conc. dam and appurts. across Mill River in Stamford and New Canaan at Highbridge; 2,000,000,000 gal. capy. reservoir. Engrs.' Est. $750,000.

Ia., Cedar Rapids—Jno. Klepach Constr. Co., local, awarded contr. for bldg. 7,500,000 gal. water reservoir at $99,720.

Fla., Jacksonville—Waterworks impvts. contracts let as follows: Earth dam, control works and appurts. to F. P. McElwrath, Corsicana, at $40,363; pump and filter plant bldgs., basins, etc., to R. C. Newcomb, Dallas, at $29,994; cast iron pipe and fittings to U. S. Cast Iron Pipe Co., Scolland Bldg., Dallas, at $15,984; valves, hydrants, etc., to Darling Valve Co., Ft. Walnut St., Williamsport, Pa., at $1,744; furnishing jointing materials to Briggs-Weaver Co., 307 N. Market St., Dallas, at $981; installing piping, hydrants, valves, jointing materials, etc., to be done by day labor, care T. E. Acker, Mayor, at $4,500; pipe gallery, filter plant fittings and valves to Morey & Morey, Dallas, at $3,743; erecting fuel oil tanks to Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, Pa., at $9,400. Will award contract later for elec. driven pumps and motors in place. Bids rejected for oil engine and pump in place.

Md., Baltimore—U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J., awarded contract for 8,000 tons cast iron pipe at $417,875; A. P. Smith Mfg. Co., E. Orange, N. J., contract for $50,000 worth of valves in connection with reservoir to be built no. of Druid Ridge Cemetery to supply Pikesville, Forest Pk., Arlington and other northwest sections, capy. 20,000,000 gals.

Mich., Monroe—A. Bentley & Sons Co., Toledo, awarded contract for constr. of filtr. plant and pumping sta., in connection with water works system, at $129,171.

Mich., Monroe—Kitchell Constr. Co., Kalamazoo,

warded contract for 3,000,000 gal. capy. rein. conc. nd pipe line extensions at $500,000.

Minn., St. Paul—Allis-Chalmers Mfg. Co., 707 let. Life Bldg., Minneapolis, awarded contracts) 3 pump units at McCarrons pumping sta., with lt accessories, at $140,700.

Mont., Red Lodge—McLaughlin & O'Neil, Liv- ngston, awarded contr. for 13,020 ft. 6, 8 and 10-in. ast iron pipe, 8,900 ft. 8 or 10-in. cast iron pipe, clear well, 2 pressure regulators, at $63,106.

N. M., Lordsburg—Jack Heather, local, awarded ontract for constr. of water and sewer systems ere, at $68,556.

N. Y., No. Tonawanda—Contr. to Hydro Constr. 'o., Mutual Life Bldg., Buffalo, for excav., grad- ng and conc., work for filter plant, pumpg. sta. ddn. and wash tank at $89,2888; superstruct. for ilter plant and pumping sta. addn., at $30,920; uperstruct. and found. for addn. to boiler rm., 3,390; Pitt Constr. Co., Fulton Bldg., Pittsburgh, ilter equipt. including settling basin and clear vater basin equipt., outside piping for high and ow serv. pumps, $74,000; plastering inside walls f pumpg. sta. addn., $1,500; automatic control pparatus, for coagulant machines, $1,200; reln. onc. filr. for portion of existing pumping sta., $20 er cu. yd.; Buffalo Steam Pump Co., 490 Bway., Buffalo, low serv. pumping engines, $10,328; Mem- his Steel Constr. Co., Magee Bldg., Pittsburgh, Pa., wash tank, $3,550; S. D. Stafford, reconstruct- ng dock wall, at $4,700.

N. Y., Wilson—Philip Agrious, Akron, O., award- d contract for constr. of village water and sewer ystems, at $70,500.

N. C., Greensboro—W. W. Boxley Co., Roanoke, Va., awarded contract to construct dam at Reedy Fork, capy. 6,000,000 gals., at $83,346; Isaac Harde- man, Charlotte, awarded contract for constr. of complete pumping unit, at $8,496.

O., Columbus—Thompson-Starrett Co. 51 Wall St. New York award. contract for Contr. No. 10 O'Shaughnessy Dam and appurtenant works at $1,165,511. Work will include 122 tons cast iron water pipe, 21 tons flange special castings, 8 tons c. i. soil pipe, 15 tons c. i. soil pipe fittings, 200 lin. ft. W. S. pipe 2-in. and less, 4,500 lbs. galv. W. S. sockets, 4 30x60-in. sluice gates and 6 36x60-in. sluice gates, 90,000 lbs. iron castings, etc., etc.

Okla., Bristow—Burke Constr. Co., Okla. City and Gibson & Mitchell, Ponca City, awarded con- tracts for water and sewer systems, at $102,947.

Okla., Okla. City—Pratt-Thompson Constr. Co., Kansas City, Mo., awarded contract for gunnite conc. slabs to reinforce banks on lake at water works dam, at $187,005.

Okla , Vinita—Jas. Shoe, Miami, award. contract for water works system, at $256,000.

Tex., Paris—McGuire & Cavender, Kansas City, Mo., awarded contract to construct dam for new reservoir, at $251,516.80.

Wn., Monroe—Northwestern Constr. Co., Seattle, awarded contract for new water system at $66,714.

Wn., Mukilteo—Troutman & Co., Seattle, award- ed contract for extensions to water system, in- cluding pipe line, at $56,000.

Wis., Milwaukee—Scoonmaker Constr. Co., 373 Bway., awarded contr. for Riverside Pumping Sta. (Pumping sta., excav., conc. foundation and sew- erage), $1,500,000.

Wyo., Mills—Mills Constr. Co., Mills, awarded contract for conc. filter bed and mains; $70,000 bonds voted for project.

Prospective Work

ROADS AND STREETS

Ala., Birmingham—Paving of 5th Ave. So. at est. cost of $88,800 is provided in Ord. adopted by Comn. providing for paving street with sheet asph. on 5-in. conc. base. Space bet. rails of Birming- ham Belt, which are to be removed, is to be paved with granite base. Ord. for paving N. 13th St.—8th to 11th Sts.—confirmed. Several additional paving Ords. have also been confirmed.

Ala., Decatur—Morgan County Bd. of Revenue will issue road bonds in sum of $409,000. Impvt. work expected to begin early next month. It is planned to begin work in each of the commis- sioner's dists. simultaneously. County projects will be built in addn. to ones contemplated by state and fed. governments.

Ala., Montgomery—State Hwy. Dept. plans 23.09 miles state hwy. from Jefferson Co. line to Chilton Co. line, at est. cost of $529,484; Chilton Co. bitum. macadam rd. from Shelby Co. line to Autauga Co. line, $580,460—both Fed. Aid Projects.

Cal., San Francisco—City and San Francisco Co. had plans prepared for impvt. of Taraval St.— 37th to 48th Aves.; 6,228 lin. ft. conc. curbs, 655 lin. ft. 8-in. and 315 ft. 12-in. sewer pipes, 6,604 sq. ft. artificial stone walks, 180,930 sq. ft. asph. conc. pavement, etc., $72,000; Buchanan St.—Her- man to Duboce Sts.—22,091 cu. yds. excav., 623 lin. ft. conc. curbs, 370 lin. ft. 8-in. vit. sewers, 4,364 sq. ft. vert. fiber brk. pavement and 7,715 sq. ft. asph. conc. pavement, $34,200. M. M. O'Shaughnessy, City Engr.

Ind., Brazil—Clay County Bd. of Commrs. have approved petition to pave E. National Ave. road from Ashley Street limit of brk. pavement east to Brazil Twp. line connecting with state hwy. sys. of conc. and National Old Trails sys. Geo. Shoehan appointed as engineer. Petition of Dr. Wm. Pal and others for impvt. of winding course thru Har- mony, approved and road ordered surfaced with crushed rock.

Ind., Ft. Wayne—Impvt. resolutions, calling for paving 3 streets and 8 alleys, confirmed at meet- ing of Board of Pub. Wks.

Ind., Indianapolis—Resolutions confirmed for re- surfacing with asphalt Delaware St.—24th to 25th Sts.; Georgia St.—Penn. to Delaware Sts.—with wooden blk. Board also adopted resolutions for perm. impvt. of Wade St.—Shelby to State Sts.; 32nd—Ill. St. to Boulevard Pl.; Oxford St.—10th to Brookside Parkway so. drive; Lockerbie St.— East to Liberty Sts.; 44th St.—College to Win- throp Ave.; 1st alley east of College—32nd to 34th Sts. and for resurfacing Washington St.—Liberty St. to 194 ft. east; also Delaware St.—19th to 22nd Sts.

Ia., Iowa City—Council voted to advertise for Muscatine Ave. paving. Alderman also voted, in addition to this 11 blks. of paving, to secure bids on impvt. of portions of Grant, Bloomington, Jef- ferson, Dodge and Madison Sts.

Ala., Merrill—Ready for bids in near future for approx. 25,000 yds. paving. W. E. Buell Co. Cons. Engrs., 205 Davidson Bldg., Sioux City; Geo. W. Simpson, City Clk.

La., Pointe a la Hache—$235,900 road bonds sold (hwy. bonds of road districts 1 and 2 of Plaque- mine Parish). The districts are on west bank of Mississippi River and extend from the Orleans- Jefferson Parish line down to Ft. Jackson reser- vation—75 miles. Surveys completed and road will be built speedily. The Quachita Parish police jury has decided on program for rd. bldg., calling for expendt. of approx. $825,000 for constr. of 46 miles of hwy. H. L. C. Daigre, Parish Engr.

Me , Gardiner—State Hwy. Dept. will build and maintain regulation State Rd. about 5 miles long bet. this city and Augusta line. It is understood that the road will be built at cost of $100,000.

Mass., Pittsfield—Order passed appropriating $68,000 for paving East Street—Wendell Ave. to 4th St. $288,000 available for paving impvts. here.

Minn., St. Paul—Prelim. orders for repaving 3 miles of streets at est. cost of $200,000, passed by Council.

Miss., Pascagoula—Jackson County Bd. of Supvrs. will advertise for bids for bldg. perm. hwy. across county. Road calls for expend. of approx. $750,000.

Mont., Helena—State Hwy. Dept. will call for bids in about 60 days for 3 Fed. Aid projects (about 50 miles) at est. cost of over $400,000. Surveys and plans completed on a number of the projects. Projects will all be surfaced.

Mont., Helena—Resolution passed by City Coun- cil to create West Side paving district. Costs estimated at from $76,500 for cement conc. to $142,500 for brick paving.

N. M., Albuquerque—Expenditures totating $367,- 000 National Forest Hwy. funds for constr. of 64 miles hwy. in state, approved by Secy. of Agri- cult. Wallace.

N. J., Trenton—State expects to improve 145

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

es of roads during 1922. Est. cost of year's
nstr. outlined under reimbursement contracts,
l cost $8,200,000. Contracts have already been
for more than 70 miles, which represents an
pendt. of $4,500,000. Bids have been asked for
additional 20 miles. County projects total 150
les more.

Nev., Carson City—Plans completed on following
ojects: No. 15, West. Co. line to Vivian, Elko
., 8.34 mi. grading; 22, West Co. line to White
ouse, Eureka Co., 6 miles, grading and gravel
rf.; 31, Eureka to Hayranch, Eureka Co., 12.2
i. grading and gravel surf.; 4, 3 mi. no. or
arters to Holbrook, Douglas Co., 4 miles grading
id 25% surfacing; 46, 6.9 mi. SE of Canyon to
6 mi. SE of Rose Well, Nye Co. 18.85 mi. grad-
g; 26, Reno to Lawtons, Washoe Co. 4 mi. grad-
g and grav. surf.; 16, West Co. line to Battle
lountain, Lander Co., 8.5 mi. widening grade and
ravel surf.; 46, thru city of Yerington, Lyon Co.,
.5 mi. 18-ft. conc. surf. Projects for which plans
re being prepared are as follows: Portions thru
ity of Elko, Elko Co., 18 ft. grav. 30-ft. rdway;
allon to Grimes Ranch, Churchill Co., 10 mi., 15-
t. grav. surf.; thru city of Fallon, 1.24 mi., 18-ft.
onc. surf.; Hazen to Wadsworth, Lyon, Churchill
nd Washoe Cos., 15.65 mi. grad'g. & grav. surf.;
Grimes to Salt Wells, Churchill Co., 5.40 mi. 15-ft.
gravel surf.

N. Y., Massena—City will expend $62,500 for
paving 4 streets and bldg. storm sewer. Taxpayers
have voted in favor of impvts.

N. C., Greensboro—Bids will be asked in about
30 days for 29 new streets—total of approx. 71,800
sq. yds., or about 4½ miles paving.

O., Massillon—City Council passed resolution
authorizing Jas. E. Willison, City Solicitor, to in-
struct service dept. to place on file immediately
the plans, specfs. and profiles of Massillon's $500,000
paving program, legislation for which has already
been passed.

O., Toledo—City plans improving Summit Street
for 11 blocks in No. Toledo. City Engr. Lewis
Owen recommends 3-in. surf. of asph. on brick
pavement.

Okla., Ponca—City Commrs. have received re-
quired petitions signed by 75% of prop. owners for
paving about 11 blocks of streets.

Pa., Bethlehem—$2,000,000 Northhampton County
bonds voted here for roads and bridges.

Pa., Catasauqua—Voters here approved bond
issue of $120,000 for perm. street impvt. Borough
of No. Catasauqua voted in favor of borrowing
$350,000 for perm. street impvts.

Pa., Philadelphia—Bill for improving Delaware
Ave. at cost of $750,000 is in City Council and
will be acted on in a few days. Chf. Dunlap of
Hwy. Bureau stated that plans are ready and
work will be pushed. Work will include grading
and paving, constructing sewers and other under-
ground impvts., etc.

Pa., Phila.—Woodlynne Council considering bond
issue in sum of $44,000 to carry on extensive street
impvt. campaign. Voters have approved the issu-
ance of the bonds.

Pa., Pittsburgh—Dept. Pub. Wks. has submitted
measure to council which would authorize city
asphalt division to prepare roadways on the two
viaducts of the Boulevard of the Allies, at cost of
$15,120. Council passed Ord. for impvt. of Pioneer
Ave. at cost of $185,000.

Tenn., Nashville—State has inaugurated new Fed.
aid rd-bldg. program involving expendt. of $8,000,-
000 for 281 miles of roads in 20 counties. This
movement has support of the auto clubs of state
and Tenn. Good Rds. Assn.

Va., Barton Heights (P. O. Richmond)—City has
tentative plans for impvt. of streets, bridges, sew-
ers, bldgs., etc., $1,500,000 available. Stewart White,
Councilman; improve Steuart Rd. from North Ave.
to Chamberlayne and Bartin from Poe St. to Boule-
vard.

Wash., Olympia—White Salmon Rd. bet. Husum
and Trout Lake in Klickitat Co. will be constructed
at cost of $150,000; county co-operating to extent
of $100,000. National Forest Hwy. funds in sum
of $575,000 made available for constr. of 50 miles
of hwy. in Washington. For constr. of 5 mi. of
rd. betw. Hughes and Orient, on Inland Empire
St. Hwy., $50,00 will be expended from Fed. funds
and an equal amt. from state co-operate funds.
Three and one-half miles Republic-Wauconda Rd.
will be surfaced at cost of $15,000.

W. Va., Wheeling—Approx. 1 mile of old Stone
Church road will be paved this year. New paving
will be of brick.

SEWERAGE AND SEWAGE TREATMENT.

Que., Montreal—City considering laying 8,624 ft.
2x3 brk. sewer in St. Joseph Blvd.—Henri Julien to
Papineau Aves., $64,780. F. V. Dowd, Asst. Supt.
Sewer Dept.

Cal., San Luis Obispo—$20,000 bonds voted here
for sewer impvts.; also $15,000 for septic tank.

Fla., Miami—$214,000 will be expended for sewer
construction here.

Ill., E. St. Louis—Resolution calling for constr.
of sewer system in northeastern section of E. St.
Louis known as Lansdowne, passed by Council.
Proj. when completed will be 18 miles in length
and will drain approx. 800 acres of land. Est. cost
$504,000.

Ky., Henderson—Bids will be asked in about 60
days for constructing complete system of sewerage.
Prelim. plans being prepared. Jno. A. Cunningham,
Commr. Pub. Wks. & Prop.

Mass., Boston—Mayor has approved orders of Bd.
of Street Commrs. for constr. work as follows:
San. seewr 24-in. earthen pipe, surface drain 4-ft.,
6-in., 4-ft. 3-in. and 3-ft. circ. conc. and 2 catch
basins in Western Ave., bet. Telford St. and Ev-
erett St. in Brighton Dist. at est. cost of $15,000;
overflow 6-ft. by 6-ft. conc. in Farragut Rd. exten.
bet. 352 ft. northwest of E. First St. and 450 ft.
northwesterly, in So. Boston Dist. at est. cost of
$43,300; san. sewer of 1-ft. 6-in. by 1-ft. 3-in. conc.
surf. drain of 1-ft. 6-in. by 1-ft. 6-in. conc. and 4
catch basins in Ipswich St. bet. 900 ft. west and
southwest of Charlesgate W. and 740 ft. northeast
and easterly in Roxbury Dist., est cost $6,765.

Minn., St. Charles—Plans being prepared for
sewer system by Engr. Chas. L. Pillsbury Co.,
1200 2nd Ave. S. Minneapolis. R. Dixon City Clk.

Minn., St. Paul—City Council passed order for
installation of new sewer on Grand Ave.—Lexing-
ton to Avon—to replace present sewers. Est. cost
of new sewer $21,055.

Mo., Cameron—Benham Engrg. Co., Kans. City,
Mo., retained as Cons. Engrs. by City for impvts.
to sewage disposal plant.

Mo., Kansas City—City will extend Blue Run
sewer. Expend $2,000,000 for piping. Paul A. Har-
tung, Engr. Will construct $1,000,000 worth of
additional sewers during year.

Mo., Kansas City—Park Board contemplates in-
stalling sewer along Swope Park. Est. cost $27,000.

N. Y., Gouverneur—Bd. Village Trustees plan to
extend storm water and san. sewerage system.
Est. cost $25,000 to $30,000. G. F. Dawley, Pres.

Neb., Grand Island—Ord. passed to create Sewer
Dist. 80, from Clark to Broadwell Ave.—12th to
13th Sts. H. E. Clifford, City Clk. $300,000 bonds
voted for storm, san. sewer system and sewage
disp. plant here. H. E. Clifford, Clk. W. E. Buell,
205-7 Davidson Bldg., Sioux City, Ia., Engrs. Ord.
also passed to create Sewer Dist. 79 from Oak to
Locust St. bet. 14th and 15th Sts.

Neb., Wayne—At meeting of City Council it was
decided to extend sanitary sewer into eastern sec-
tion of town. Engineer will be retained to look
after the work.

N. H., Manchester—Specfs. for new sewer pro-
ject being worked out by Hwy. Surveyor Conant.
Reinf. conc. pipe to be made at sewer job on Beech
Street will be contracted for. Sewer work 1½
miles in length.

N. M., Artesia—$50,000 bonds voted for sewerage
system and disposal plant. C. O. Brown, Mayor.

N. Y., Brooklyn—Final approval given by Boro.
Pres. Connolly to plans and specfs. for 5 sewer
extensions, two of which are in Corona, two in
Flushing, and one in Ridgewood. Total est. cost
will be more tha $50,000.

Ohio, Barnesville—City will install sewerage sys-
tem at estimated cost of $450,000.

Ohio, Lima—City Comn. has adopted plans for
direct oxidation sewage disposal plant.

Ohio, Maple Heights—Will advertise for bids in
July for sewerage sys. Segment blk. and some
brick. Also sewage treatment station. Est. cost
$300,000. C. W. Courtney, Leader-News Bldg.,
Cleveland, Engr.

Okla., Muskogee—City will soon ask bids for
about 9,000 lin. ft. sanitary sewers.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Tex., Pampa—City will construct water works and sewerage system. $80,000 bonds voted.

Va., Barton Heights (P. O. Richmond)—City has tentative plans for impvt. of sewers, streets, fire house, etc., $1,500,000 available. Stewart White, Councilman.

Wis., Milwaukee—Metropolitan sewerage commission considering plans for intercepting sewer for sewage of Whitefish Bay and Shorewood; also another to take care of W. Milwaukee and City of West Allis. Est. cost of two sewers, approx. $150,000.

Wis., Mukwonago—Contemplate water and sewer extens.: 3,800 ft. 4 and 6-in. cast-iron water mains; 12,800 ft. 6, 8 and 10-in. vit. sewers. G. Dillenbeck, Vil. Clk. W. G. Kirchoffer, Madison, Engr.

WATER SUPPLY AND PURIFICATION.

Cal., Pasadena—Municipal Water Dept. will lay 20-in. main on E. Colorado St. bet. Euclid and Mentor Aves. Est. cost $50,000.

Cal., San Diego—Hydr. Engr. H. N. Savage preparing detailed plans for work necessary to enlarge spillway at Morena dam. Est. cost of work $100,000.

Cal., Vernon—Howard McCurdy, 335 Pacific Elec. Bldg., Los Angeles, City Engr. of Vernon, has submitted to city trustees a report on new high pressure water sys. for industrial city adjoining Los Angeles. Est. cost $450,000. Bond issue will be submitted soon. Proj. will involve abt. 63,000 ft. cost iron pipe, 8, 10, 12, 14 and 16-in. diam.; approx. 2,908 tons pipe and 57 tons fittings; 100 gate valves and 205 fire hydrants. New well will be driven on city property at Vernon and Santa Fe Aves. and motor-driven turbine pump with capy. of 1,500 gals. per min. under 125 ft. head will be installed. There will be a 3,000,000 gal. reservoir, excav. and embank., 182x182 ft. at top and 16 ft. deep with 2 to 1 slopes lined with conc., reinf. with wire mesh; wooden roof; excav. abt. 2,700 cy. yards. 3 centrif. pumps, 1,250 gals. per min. operated by gas, motors, will pump water from reservoir into mains.

Que., Hull—$59,000 bonds voted here for extension of water works and sewer systems. T. Lanctot, City Engr.

Que., Montreal—Director of Pub. Wks. decided to recommend to executive committee the laying of a 48-in. water main from Pt. St. Charles Pumping Sta. to a point in vicinity of Place Viger Hotel, a dist. of abt. 2 miles.

Ont., Port Credit—Detailed plan of proposed water works sys., submitted to Town Council by Wm. Storrie of Gore Nasmith & Storrie, Cons. Engrs., Toronto. Est. cost $120,000. Plans approved by Provincial Bd. of Health.

Ont., Thornbury—Plans being prepared for new water works sys. $30,000. Prices wanted on pumps, pipe, etc. James, Proctor & Redfern, 36 Toronto St., Toronto, Engrs. These engineers also consultants on water works for Woodbridge, Ontario. Prices wanted on material and equipment.

Colo., Colo. Springs—Col. A. R. Humphreys, Denver, reported to be planning erection of a $100,000 water impvt. proj. on Goose Crk. above Wagon Wheel Gap.

Colo., Grand Jct.—Specfs. and estimates being prepared for new water works impvts., including new reservoir . Est. cost $150,000. G. Garrett, City Mgr.

Colo., Oak Crk.—City planning to constr. new water works storage reservoir on Oak Creek. Modern filtr. sys. will also be installed. Plans to be prepared by Chas. Vail, Engr. of State Pub. Utilities Comn. G. F. Watt, Mayor.

Ia., Marshalltown—City contemplates constr. of water plant. Alvord & Burdick, 8 S. Dearborn St., Chicago, Cons. Engrs. $355,000. Anne McMahon, City Clk.

Ia., Oskaloosa—$230,000 bonds carried for purch. of water works plant; $70,000 for water works impvts. and $370,000 for hydro-elec. development on Des Moines River.

Kans., Hutchinson—City considering purchase of water works of United Water, Gas & Elec. Co. No date set for bond election by the people. In meantime, however, City has reached agreement with Company that latter is to install new mains and pumping station to extent of $150,000 at once and to improve the service. Agreement also includes provision for establishment of water mains under 13 blks. of new pavement which is to be built at once. Mains will also be built and pressure maintained, to some of the industries which have insufficient service at present.

La., Cedar Grove—City will construct water works, sewer systems and street impvts. $125,000 water bonds voted; $100,000 sewer and $62,500 street bonds.

La., Winnsboro—Town will construct water works plant, install pumping plant, 100,000-gal. capy. $45,000. Kramer Engrg. Co., Magnolia, Miss., Engrs.

Me., Auburn—City will soon take bids for main extension from Lake Auburn pumping station, 12,000 tons cast iron pipe. A. W. P. Cobb, Clk., Water Comn.

Md., Baltimore—Architectural Comn. has selected Wm. W. Emmart, 1101 Union Trust Bldg., as Archt. for filtration plant at Montebello. $1,000,000. Est. to treat 90,000,000 gals. of water.

Md., McCalls Ferry—United Gas & Elec. Corp. (main office New York) E. G. Gonette, Pres.; Francis T. Homer, Baltimore, reported to develop hydro-elec. plant on Susquehanna River bet. tidewater and plant of Penn. Water & Power Co., at Holtwood. About $1,360,000 invested. Constr. work will probably start in February, 1st dam to be built near Conowingo.

Minn., Lake City—Considering laying water mains in abt. 85 blks. 32,000 lin. ft. 6 in. and 750 lin. ft. 4 in. cast iron pipe, etc. $50,000. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Engr.

Minn., Winsted—Jno. W. Schaffer & Co., 917 New York Life Bldg., Minneapolis, has made survey for water works system. Est. cost of impvt. $50,000. Maturity indef. Fred Rouf, Clk.

N. C., Lexington—Bonds to amount of $300,000 have been sold for constr. of water and sewer systems.

N. C., Winston Salem—Engrg. Div. of Dept. Pub. Wks. will ask for bids within next 30 days for extensive impvts. to water plant; install 6 filters, constr. coagulating basin, wash tower, etc., install aerator, etc.

Ohio, Barberton—J. N. Chester, Engrs., Union Bank Bldg., Pittsburgh, Pa., retained by City to prepare plans and specfs. for an iron removal plant; also to make an investigation and report on the water supply.

Okla., Tulsa—Bids will be opened in Summer for $6,800,000 water supply project. J. D. Trammell, Cons. Engr., Ft. Worth, Tex.

R. I., Cent. Falls—Town considering impvt. and extension of water pipe system. $150,000. S. P. Cummings, City Engr.

Tex., Lamesa—Plans being prepared by Elrod Engrg. Co., Interurban Bldg., Dallas, for water works impvts. $60,000. M. H. Horton, City Secy.

Tex., Pampa—$80,000 bonds voted for installation of water works and sewer systems.

Va., Ashland—Extension of water and sewer system at cost of $70,000, being considered.

Wn., Puyallup—$75,000 bonds voted by City to replace water works system, iron or wood pipe. O. C. Gregory, Engr.

Wn., Tacoma—City expects to replace 30-in. wooden main in So. Cushman Dist .with 20-in. cast iron pipe. Est. cost $84,550. E. C. Manley, City Engr.

Wn., Walla Walla—Engr. E. B. Hussey, Alaska Bldg., Seattle, reports completion of plans and specfs. for Div. No. 2 of water works extension program. Div. No. 2 of the development will necessitate expendt. of about $140,000. Work will include constr. of 4-mile, 20-in. pipe line into the Wenaha national forest to tap purer water supply, constr. of gravity type dam 100 ft. wide and 16 ft. high, constr. of sluice gates, telephone pole line and wagon road into intake.

Wis., Rice Lake—Water works extensions and impvts. planned. Est. cost $40,000. O. Jenson, Clk. Engr. not selected.

Wis., Sturgeon Bay—City Council agreed on plan to drill well on top of Garland St. hill, erect 500,000 gal. reservoir and extend water mains down Garland St. to connect with mains in other parts of City. First move will be to call for bids for sinking 10 in. well deep enough to secure the water. Est. cost of this impvt. $3,000. Cost of reservoir estimated at bet. $40,000 and $50,000.

Wyo., Basin—At recent election it was voted to issue $60,000 bonds for water works impvts.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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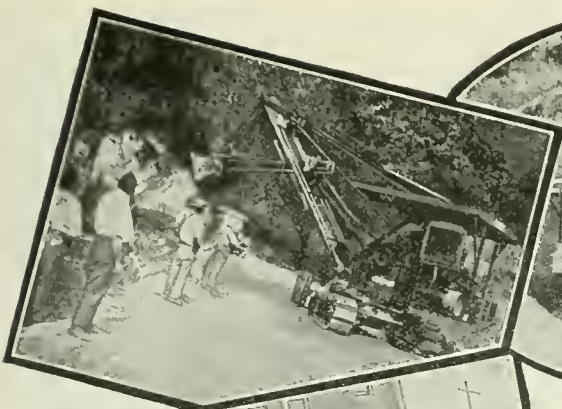

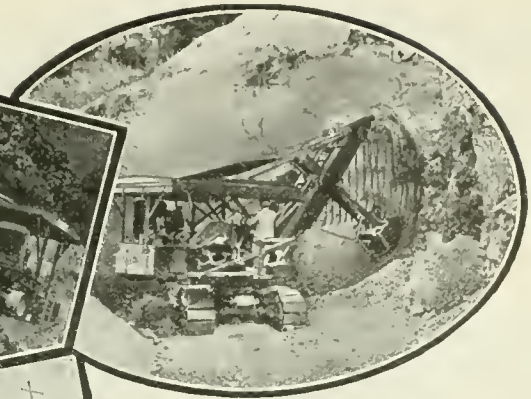

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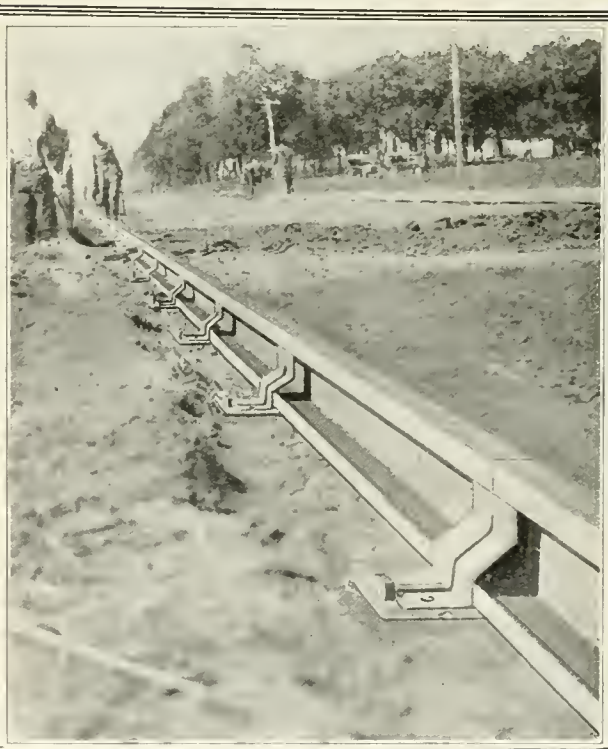

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BUILT LIKE A RAILROAD

Illustration at the left shows the perfect alignment secured with **Heltzel** Steel Forms.

This perfect alignment is a result of **Heltzel** Steel Forms being built like a railroad—a rail, a pedestal and a stake—no keys, wedges or clamps. No right or left hand rails.

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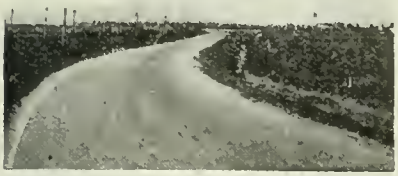
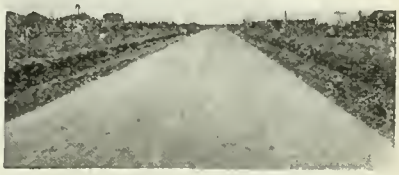


Texaco Sheet Asphalt on Beaumont - Port Arthur Road, Texas. Photo taken after five years' service—no maintenance.

Interest in the Lone Star State centers about its importance in the petroleum industry;—its vast area, which is greater than the combined area of the Atlantic Coast States from Maine to Virginia;—its great railroad system, which represents a mileage exceeding that of any other State;—its extensive agricultural lands;—and possibly the tremendous scale on which ranching and grazing is carried on in the State.



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There is another thing about Texas, however, which is of extraordinary interest to those in the road building field.

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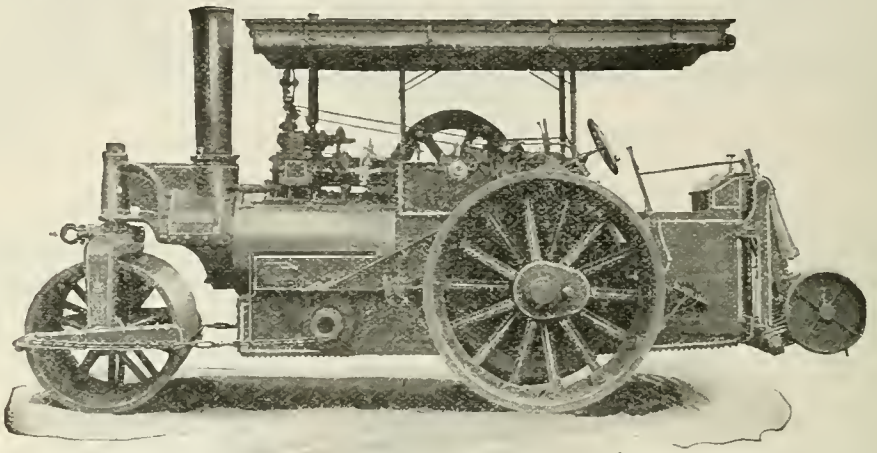

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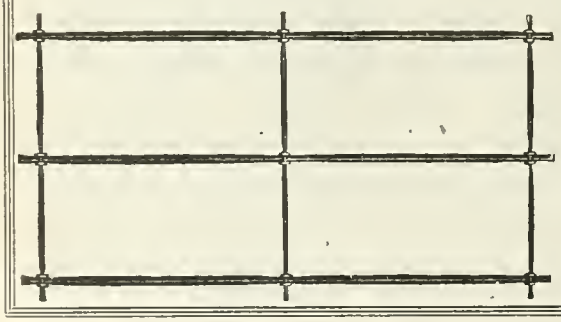

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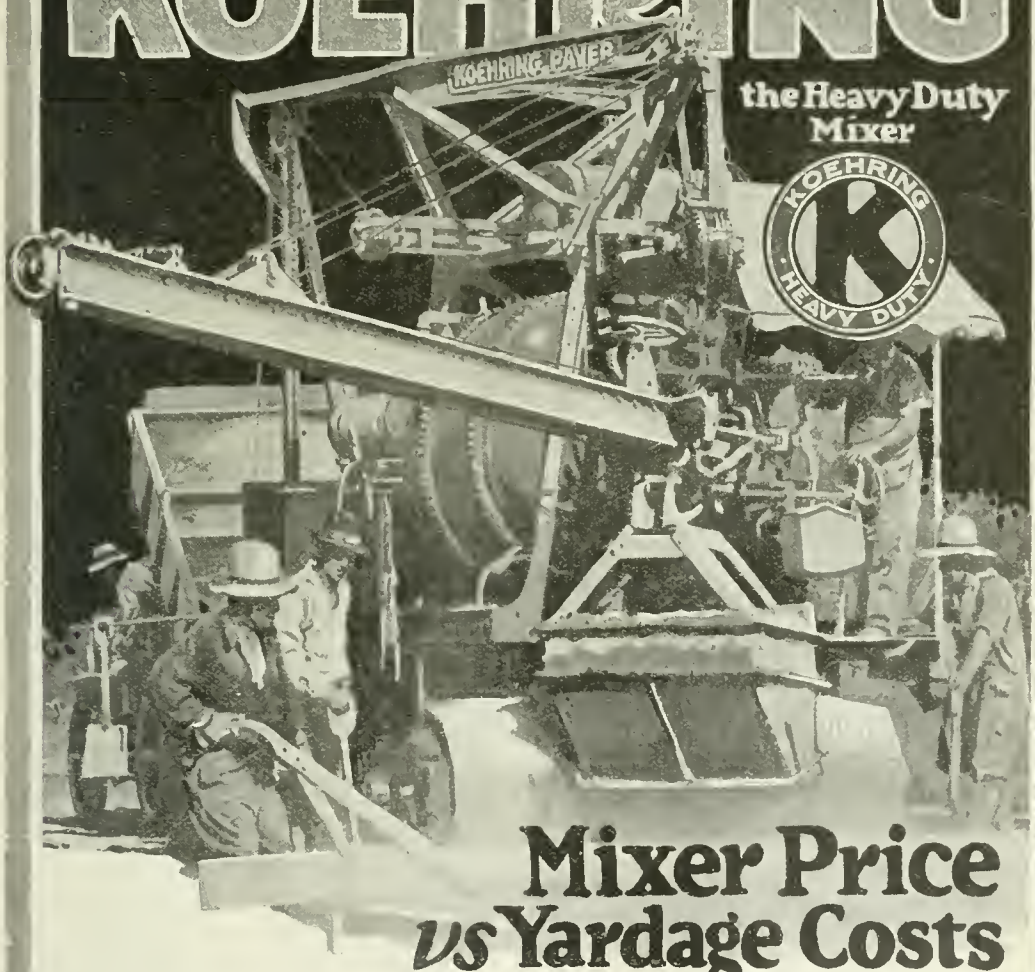

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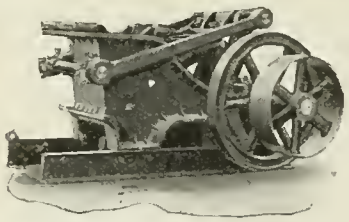

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The Jaw Crusher that is *Different*

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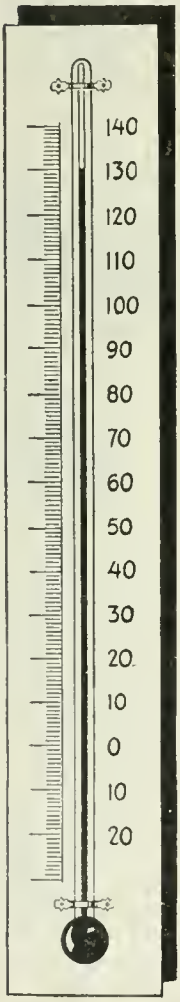

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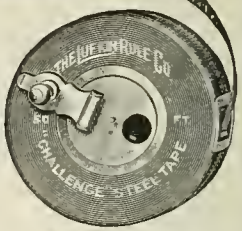

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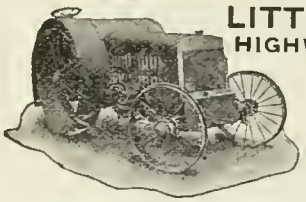

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Enclosed spring drawbar, prevents damage to tractor or its load by jerk in starting or while in motion.

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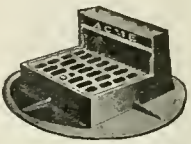

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Motor Truck Operation and Accounting—84

HUSTLING YOUNG CONTRACTOR AVERAGES OVER 1,000 FT. OF 18 FT. CONCRETE ROAD PER DAY

To the Editor:

A first class organization and a keen interest shown on the part of each workingman is the cause of the splendid record which is being made by J. P. Connell, a young contractor of Janesville, in Southern Wisconsin.

On May 15th work was started on seven miles of concrete in Jefferson County, Wisconsin, and up to date over six miles have been completed. During this time work has been delayed about twelve whole days, due to rains and four days' delays which were necessitated by moving equipment from one town to another.

The material is shipped in and unloaded from cars by a clam-shell and dumped into a Kissel specially designed hopper. This hopper is operated by one man and with a turn of a lever will fill a truck with two batches of sand and gravel in three seconds.

The truck leaves the hopper and is driven to a cement car stationed on a side track nearby where the required number of cement sacks are emptied into the truck on top of the sand and gravel. They then speed to the scene of operation where one hundred or more feet in front of the mixer the truck is turned around on a Kissel turn-table and is then in a position to back up the sub-grade to the 5-bag mixer where the batch is mixed and dumped on the grade. A finishing machine, operated by one man, keeps up with the mixer.

Eight Kissel trucks with specially designed batch boxes have kept the mixer on the go from morning till night.

In order to avoid tie-ups, which many times happen from delayed freight, a store-pile, which holds 75 cars of sand and gravel, is kept beside the hopper. A day and night shift keep the material unloaded and therefore no worry is experienced when the gravel pits, many miles away, are unable to make shipments.

The interest taken by the people in the community, as well as that of the workmen, has much to do with the success of this work. At the completion of each day's work the number of feet of concrete laid causes great interest and discussion as to whether or not more feet can be laid on the day following.

On July 19th, the wind-up of a five-mile stretch of 18 ft. concrete, 1,118 ft. were laid in 11½ hours. In a period of five days just previous to this, 5,136 ft. of concrete were laid.

This contractor has taken four miles more of concrete road and expects to have the work completed this fall. This includes culverts, grading, shouldering and everything that has to do with the completion of the road.

This work received a very high compliment a few days ago from the Portland Cement Association Inspector.

Very truly yours,
R. D. *Royce*, County Highway Com.
Jefferson, Wis., July 26, 1922.

TEXT OF COLORADO DECISION AFFECTING COMMERCIAL USE OF HIGHWAYS

(Editor's Note:—Quotations from the decision of the Public Utilities Commission of the State of Colorado, affecting the commercial use of highways in that State, have been widely published. We present the full text of the decision herewith for the convenience of our many readers who are interested in the use of highways. It is important to study all regulatory measures, even if they are only local in scope, while a general policy of highway commercial traffic regulation is in the first stages of formulation.

The specific case covered by this decision has not been adjudicated in any other Colorado court, and this decision of the Commission had not yet been appealed to any other tribunal on July 22, 1922, according to a letter written us on that date by Mr. Charles H. Small, Secretary of the Commission.

The decision is given in full for the thoughtful consideration of readers. We do not believe in the suppression of news, even if the news is not entirely to our liking. The specific case on which this decision was based is comparatively unimportant and of no great interest to the public. But some of the Commission's generalizations seem rather sweeping and

dangerous to the development of the commercial use of highways. If some of these generalizations are used as precedents by similar regulatory bodies hardships to individuals and communities will result.

Regulation in some form must come but it must be fair and eventually will be fair. To keep out injustice during the formulative period, which may be ruinous to many firms and individuals, we hope the best minds in the motor industry will take hold of this general subject and assist in placing it speedily in a position where justice will be done all parties. We will welcome discussion of the subject for publication.)

The decision, No. 518, Application No. 134, was rendered on March 8, 1922. Decision was rendered: In the Matter of the Application of Ralph McGlochlin for a Certificate of Public Convenience and Necessity for the Operation of an Automobile Passenger and Freight Line between Glenwood Springs and State Bridge, Colorado, via Wolcott.

Statement by Commission

The application herein was filed with this Commission April 25, 1921, and was set down for hearing and was heard in the Hearing Room at the State Capitol, Denver, Colorado, Thursday, Jan. 19, 1922.

Alexander R. Baldwin, receiver of the property of The Denver and Rio Grande Western Railroad Company, by his attorneys, E. N. Clark and Thomas R. Woodrow, filed, May 10, 1921, protest on behalf of the railroad company against the granting of a certificate under this application. Since the filing of the protest, the Receiver has been discharged and the railroad has passed into the hands of The Denver and Rio Grande Western Railroad Company.

The applicant, Ralph McGlochlin, asks that the Commission grant him a certificate of convenience and necessity for the establishment and operation of an automobile passenger line between Glenwood Springs and State Bridge, via Wolcott, all of which points are within the confines of Garfield and Eagle counties, Colorado. The proposed line, starting at Glenwood Springs, would run over the State highway through Garfield county, to the county line in Eagle county, thence through Eagle county through the towns of Dotsero, Gypsum, Eagle and Wolcott and terminate at State Bridge, Colorado, on the Denver and Salt Lake Railroad.

More than $600,000 has been expended on about 15 miles of State highway through the canyon, along the Colorado river, east of Glenwood Springs. It forms an important link in the highways between eastern Colorado and Utah and California and for scenic beauty is unsurpassed in the western country.

It was brought out at this hearing that the petitioner intended to limit the operation of his auto busses to only four months in the year; namely, June, July, August and September, when he could operate at the minimum of expense and maximum of profit.

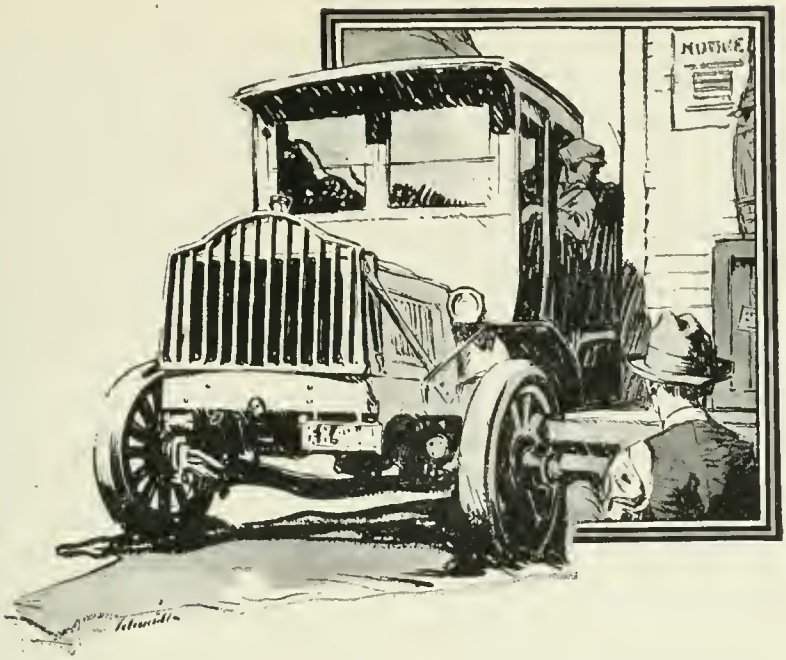
This service is claimed to be not only a convenience but a necessity as well. Obviously when roads are muddy in spring and fall and also when deep snows have to be contended with by the traveling public in winter, it is at these times, if ever, when passenger conveyances become not only a convenience but an absolute necessity as well. Right at this time is when this applicant proposes to cease to function as a common carrier, which leads this Commission to the conclusion that this certificate is sought not so much to meet the conveniences and necessities of the traveling public as it is for private gain.

This hearing brought out the fact that this railroad company actually loses money on its through travel, while the profitable haul comes from its local passenger travel. Even at this, the fare by rail from Wolcott to Glenwood Springs is only $2.22, while the applicant proposes to charge $3.00, by auto bus, between the same points.

One of the important reasons alleged for a certificate, by this applicant, was the fact that No. 1, the "Scenic Limited" of the Denver and Rio Grande Western, did not stop at Wolcott, thus compelling passengers coming over from State Bridge and bound westward to remain over night at Wolcott and pay hotel bills. Feb. 28, 1922, the railroad company issued an order, effective at once, that train No. 1 will stop on flag at Wolcott for passengers, so that this feature of the argument for a certificate has been elimited.

The evidence introduced in this case shows that the railroads in Colorado paid in 1921 *State road taxes* aggregating $159,875.42. Of this amount The Denver and Rio Grande Western Railroad contributed for roads for the 1921 period, $45,207.12. In 1921 this road paid in taxes in Eagle county $61,240.09, and of this amount The Denver and Rio Grande Western contributed to the county road tax of said Eagle county, $16,709.89.

The testimony also shows that The Den-



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The owners of thousands of Packard Trucks all over America, chose them for no other reason than their proven merit;—an intensely significant fact for all who are now, or will be, in the market for motor trucks.

This soundly founded preference for the Packard Truck is made even more pronounced by its price—recognized to be not only eminently fair, but also lower than that of other trucks of comparable quality.

Packard Trucks range in capacity from 2 tons to 7½ tons; and in price from $3,100 to $4,500

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Packard Service

In 585 Cities and towns throughout the United States, Packard Truck Service stations give owners highly skilled service at a reasonable cost. Packard Truck costs, always low because the sound Packard construction minimizes the need of repair, are held still lower by this expert, broadcast service.

PACKARD TRUCKS

ver and Rio Grande Western Railroad Company paid Garfield county in 1921 taxes to the amount of $92,656.85, and of this amount $21,314.05 was for the upkeep and construction of roads.

The vehicle registration report of Colorado, compiled by the Secretary of State, for 1921, shows that Eagle county had seven trucks and paid in revenue to the State the sum of $54.25. Also, that Garfield county had 61 trucks and paid into the State treasury $765.02, or a total for the two counties of only $819.27 for the use of the State and county highways that the trucks use, while The Denver and Rio Grande Western Railroad had to pay in the same two counties, for the same period, more than forty-six times as much, or $38,023.94 for the roads they do not use at all.

As to the adequacy of service for the town of Wolcott, we find No. 16 eastbound Denver and Rio Grande Western train makes a regular stop at Wolcott at 6:06 p. m. No. 4, also eastbound, stops on flag at 11:59 p. m., while No. 2 eastbound at 7:55 a. m. stops on flag to discharge passengers from Glenwood Springs and points west. There is also a freight train, No. 94, eastbound daily, excepting Sunday, that picks up and discharges passengers at all stations between Glenwood Springs and Wolcott.

Westbound No. 15 stops on flag at Wolcott at 9:28 a. m. to pick up passengers for Eagle, Gypsum, Glenwood Springs and other intermediate points as far as Grand Junction. No. 3 westbound has a flag stop at Wolcott at 4:36 a. m. and has a regular stop at Eagle and a flag stop at Gypsum and a regular stop at Glenwood Springs and all other points of considerable importance as far as Grand Junction. No. 1, the Scenic Limited, also stops on flag at Wolcott at 8:45 p. m., thus taking care of passengers from State Bridge, whose destination is westward on The Denver and Rio Grande Western. In addition to the aforesaid service, freight train No. 93 leaving Wolcott daily, excepting Sunday, at 1:38 p. m., picks up and discharges passengers at all stations westward and arrives in Glenwood at 5:20 p. m.

Taking into consideration the size of the town of Wolcott and the fact that the traveling public have access to three trains in each direction on Sunday and that there are four available trains both east and west every other day in the year, it would seem that there is no need for additional passenger service between Glenwood Springs and Wolcott. In fact, we believe these people are far better off than those of many more populous communities in not only this but other states as well. A reflex of the conditions is found in the fact that the total ticket sales from Wolcott to all points west, including Glenwood Springs, for 1921, amounted to only $664.77.

The record in this case shows The Denver and Rio Grande Western, in 1921, paid in Garfield and Eagle counties taxes totalling $153,896.94 and that over $38,000 went into the road fund of these counties. Viewing this whole matter from the point of present adequacy of transportation facilities and in the light of a decent regard for the rights of others, it would seem inequitable and unjust that the vast sums wrung from the railroads, especially in the shape of road taxes, should be used to provide means to encompass their own destruction.

Looking at all the facts in this case, it would seem manifestly unfair for this Commission to grant a certificate to this applicant that he may skim off the cream of the passenger traffic during the summer months and then leave the railroad to battle with the elements during the balance of the year when railroad operations are a heavier financial burden and passenger travel is exceedingly light.

But leave the railroad entirely out of the case and view it only from the standpoint of the farmer and city home owner. They pay a very large proportion of taxes assessed for highway construction and maintenance. Some of them own and operate automobiles and some do not. If they do, the damage to roads from the occasional operation of their light, pneumatic tired cars is practically negligible. They seldom use the roads under weather conditions such that their use is destructive, while at certain seasons the heavily loaded freight and passenger trucks plough back and forth making great furroughs in the road regardless both of conditions and consequences. Under weather conditions producing softened roadbeds, the passage of a single heavily loaded truck will do greater damage to a highway than would the passage of hundreds of ordinary cars. The farmer and the city home owner pays the bills and the 136,336 passenger car owners of the State are grievously wronged.

Public convenience and necessity, by which must be understood the convenience and necessity of the people at large as contra-distinguished from the convenience

and necessity of a very small number of persons who seek to derive a profit from the farmers' and home owners' investment in roads, never contemplated that the truck driver should destroy that, to the cost of construction of which he contributed little or nothing, or that he should reap where he has not sown.

When the taxing laws of this State are so amended that the truck driver operating over state highways shall contribute his due proportion to the cost of construction and maintenance of our highways, then, and not until then, can this Commission regard his use, under proper conditions and restrictions, of a great and tremendously expensive public facility as of equal dignity and equal benefit to the people with the moderate use thereof by the ordinary taxpayer.

Viewing this case in all its aspects, this Commission finds there is no existing necessity for an auto bus passenger line between Glenwood Springs and Wolcott. It also finds that the service furnished by The Denver and Rio Grande Western Railroad Company between Glenwood Springs and Wolcott is fully adequate to meet the reasonable necessities of the traveling public during the entire year.

The Colorado Public Utilities Act limits the Commission's authority over the issuance of certificates of convenience and necessity to automobiles in competition with railroads. As there is no such competition between Wolcott and State Bridge, the Commission holds it has no authority over this part of the route.

For the aforesaid reasons, this Commission will deny the prayer of the applicant for a certificate for that part of the proposed route between Wolcott and Glenwood Springs on the grounds that there is no necessity shown to exist for such automobile passenger line.

Order

IT IS THEREFORE ORDERED, That the application of Ralph McGlochlin for a certificate of convenience and necessity for the operation of an automobile passenger line between Glenwood Springs and State Bridge, Colorado, be, and the same is, hereby denied over any and all that portion of the proposed route between Glenwood Springs and Wolcott, Colorado.

FEDERAL FAST EXPRESS TRUCKS ON MARKET

The first of the recently announced Federal Fast Express Trucks left the Federal Motor Truck Company, Detroit, Tuesday afternoon, bound for Milwaukee, Wis. The first 50 trucks of this new model will be driven from the factory by dealers, leaving the factory in varying numbers each day.

The report of the driver of the first new model has just been received at the factory. It bubbles with enthusiasm. One hundred fifty-two miles were covered the first day, a stop being made for the night at Paw Paw, Mich.

"To my surprise, when I opened the gas tank," continues the report, "for the last lap of my journey the next day, I found that I still had a few gallons of gasoline (the tank only holding 12½ gallons), giving me a little better than 15 miles to the gallon.

"My lubricating oil gauge showed better than ¾ full, but I chucked in a quart for good measure and did not put any more in on the trip, neither did I put a drop of water in the radiator during the entire trip."

Leaving Paw Paw at 8 o'clock Wednesday morning, the writer states he arrived in Milwaukee shortly before 9 o'clock in the evening. So pleased was he with the truck that he took the purchaser out that same night for a spin. "She sure is the snappiest little bus I ever rode in, and am sure glad I waited for it," was the way the customer described it.

The second Fast Federal Express to leave the factory made the 204 miles to Columbus, Ohio, in 9 hours 40 minutes, using ½ gal. of oil and 15½ gals. of gasoline.

FINANCING OUR FUTURE HIGHWAYS

"Plan now the financing of highways for the future and place highway transportation, which has come to be an indispensable part of our national life, on a firm foundation." This is the advice given by Thomas H. McDonald, Chief of the Bureau of Public Roads, United States Department of Agriculture, for the consideration of every voter, taxpayer and legislator.

"We are starting out to construct a system of highways such as no nation ever constructed before. The nearest approach to it is found in France and Germany, and the area of neither is as large as Texas. This great undertaking is being entered into because highways are not a luxury but furnish a real service,

have a real earning capacity, and have become a national necessity.

"For such an undertaking to be successful, financing to care for maintenance, reconstruction, and new construction should be planned for a long period of years in advance. Changes in methods of raising funds every few years, uncertainty as to whether funds will be provided, and periods in which funds are not provided, all increase the final cost of highways. Such a policy would soon bring any private business to disaster.

"Development and increase in numbers of motor vehicles and the coincident need and demand for good roads have come so rapidly that methods of raising funds have often been expedients for the time being. Consideration has been given not so much to the just distribution of the cost as to how the funds can be raised with the least controversy and the utmost ease. Then, too, the use made of the highways and the service rendered by them has changed greatly within the last few years.

"All this leads to the conclusion that the whole situation should be gone over very carefully, traffic studies made, and the cost distributed in proportion to the service rendered.

"The Bureau of Public Roads estimates that of the $600,000,000 spent for highways last year 33 per cent was federal aid and motor vehicle revenue. The remaining 67 per cent comes either directly or will eventually be paid from state and local taxes. It is believed that a very considerable readjustment of the source of revenues must be made so that a larger percentage will be paid by the road user and a lesser percentage from state or local taxes."

PERMANENT INTERNATIONAL ASSOCIATION ROAD CONGRESSES

The Executive Committee of the Permanent International Association of Road Congresses announces that the Fourth International Road Congress will be held in Seville, Spain, in May, 1923. The Congress will be in session for six days.

The object of the Association is to promote and record progress in the improvement of highways and the efficient development of highway transport throughout the world. The work of the Association consists in organizing and conducting International Road Congresses, publishing the proceedings of its Congresses and other documents, and collecting information relative to highway improvement and highway transport. A bulletin of the Association is issued four times each year. The bulletin contains complete minutes of the meetings of the Permanent International Commission and the Permanent Council, announcements by the Executive Bureau, and progress reports on highway engineering and highway transport practice throughout the world. Each member, who resides in the United States, receives copies of the English editions of all proceedings, bulletins and other literature published by the Association.

The membership of the Association consists of representatives of governments and corporations, and individual members. The business affairs of the Association are managed by the Permanent International Commission, which is composed of members representing the various governments having membership in the Association. Each government has the right to one representative for each 1,000 francs of its total annual subsidy, provided that the number of representatives from any one government does not exceed 15. Unfortunately, the United States Government is the only world power which has not been affiliated with the Association.

The First International Road Congress was held in Paris in 1908. At this Congress, the Permanent International Association of Road Congresses was formed with headquarters in Paris. The Second Congress was held in Brussels in 1910. Following the Second Congress, the Permanent International Commission adopted a resolution to the effect that an International Congress should be held every three years. The world war, of course, interfered with this program after 1913.

The Third International Road Congress was held in London in 1913 and was attended by 3,793 members, of which 139 were from the United States. Fifty-two nations were represented at the Congress, 44 governments having official representatives. The business sessions of the Congress occupied about one week and were devoted to a thorough discussion of 149 reports pertaining to the 19 topics on the program of the Congress. During the final business session, progressive conclusions relative to every main topic were adopted by the Congress. The reports, which were presented by reporters from 19 nations, and the proceedings of the Third Congress measure, when stacked, about 6½ ins. by 9½ ins. by 8 ins. in height.

CONTRACT AWARDED ON IDEAL SECTION OF LINCOLN HIGHWAY

The far-famed stretch of model road known as the Ideal Section of the Lincoln Highway is, after nearly two years of preliminary research and detailed work, now under construction in Lake County, Indiana.

The contracts for the construction were closed recently in Indianapolis, when Stone & Webster, Inc., of Boston, Mass., acting as agents for the Lincoln Highway Association, undertook to build a section of road which will cost, with all appurtenances, approximately $100,000 a mile, at a price of $33,000 per mile to the State of Indiana. Stone & Webster, under whose supervision the work will proceed, let the construction contract to J. C. O'Connor & Sons of Fort Wayne, Ind. Already the work on this stretch, which will perhaps be one of the most talked-about and studied sections of highway in the world, is under way.

In addition to the $33,000 per mile provided by the State, Lake County authorities have assured $25,000 from the County funds and steps have already been taken by the County Council and Commissioners to provide this sum as the County's share. The extra expense of the Section beyond the sum supplied by the State and County, which is equivalent to what the construction of the usual state specifications would cost, will be met by the Lincoln Highway Association, through a special fund provided by the United States Rubber Company. It is expected that the paving work will be completed by the end of October, many details including the lighting installation; the beautification of the right-of-way, etc., remaining for accomplishment in the spring of 1923.

In the design of this unique section of the Lincoln Highway is embodied the mature thought of 15 of the foremost experts in highway enginering and construction and related problems in the United States who, acting without recompense as the Technical Committee of the Lincoln Highway Association, developed the general plan which was carried to detailed completion through the collaboration of the engineering department of the Indiana State Highway Commission, C. Gray, State Highway Engineer, Lockwood, Greene & Company, Engineers, and W. G. Thompson, formerly State Highway Engineer of New Jersey, the Association's Consulting Highway Engineer. Federal Aid of $20,000 per mile has been allowed by the Bureau of Public Roads of the Department of Agriculture, toward this construction, the development of which will be closely followed by the Federal authorities.

The ideas embodied in the design of the Ideal Section which will stand for years at its central location on the Lincoln Highway as a model for the gradual evolution of the entire route as traffic volume increases, impress many important lessons through which the Association hopes to inform and mould public opinion of the United States. The design calling for 40 ft. of 10-in. reinforced concrete pavement, capable of carrying a traffic of 20,000 vehicles per 24-hour day, one-quarter of which are estimated to be heavily laden trucks, impresses the necessity of permanency in our modern, highway investments on main routes of travel. The width makes for safety and facility of operation. The absence of drainage ditches at the side of the road further inculcates the safety idea, while the night illumination increases the road efficiency by permitting a heavy volume of night traffic without danger. The beautification of the roadside is in line with steps now being taken by the most advanced highway departments, which are realizing that too little attention has been given in this country to the importance of a proportionately small expenditure to realize the greatest beauty of the roadside.

While it is not expected that many states can undertake, in the near future, improvements embodying all of the principal elements of the Ideal Section design, it is felt by the Lincoln Highway Association and the officials of the United States Rubber Company, which made the object lesson section possible, that the design will be suggestive and will tend to bring to the attention of the American public the vital necessity of adequacy in present day specifications, if the hundreds of millions which are now going into highway construction are to properly serve the America of today and tomorrow.

FELLOWSHIPS IN HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT

Two of the following Fellowships will be awarded not later than September 1 and two not later than November 1, 1922, by the Board of Regents of the University of Michigan.

The Roy D. Chapin Fellowship in Highway Transport, which is offered to pro-

vide for the investigation of an approved subject relative to highway transport.

The Roy D. Chapin Fellowship in Highway Engineering, which is offered to provide for the investigation of an approved subject relative to hard surfaced roads and pavements.

Two Detroit Edison Fellowships in Highway Engineering, which are offered to provide for the investigation of approved subjects relative to moderate cost country roads.

General conditions: Each Fellowship pays the sum of $250 with an allowance of $50 for expenses. The holders of these Fellowships do not have to pay tuition fees. A Fellow must hold a Bachelor's degree from a college of recognized standing. He must enroll as a graduate student in highway engineering or highway transport and as a candidate for the degree of Master of Science or Master of Science in Engineering. He must be in residence for one of the following periods: First semester (October to February), winter period (December to March), second semester (February to June). An application for a Fellowship must include a concise statement of the candidate's educational training and engineering experience, and three references. Applications and requests for information pertaining to the 25 advanced courses in Highway Engineering and Highway Transport offered by the graduate school should be sent to Professor Arthur H. Blanchard, Engineering Building, University of Michigan, Ann Arbor, Mich.

DECIDED IMPROVEMENT IN ENGINEERING EMPLOYMENT

A gradual and steady advance in engineering employment in all sections of the country with increased activity in many basic industries is reported by the employment department of the American Association of Engineers. The building industry has been most active. There have been some irregularities in manufacturing. The coal mining and railroad fields show a slight setback, due possibly to labor difficulties, but technical men are in demand. Highway and municipal work are progressing with added vigor, and employers in these fields find it difficult to locate experienced men. The demand for architectural and structural draftsmen and designers with building or plant experience has far exceeded the supply in practically all sections of the country.

Employment conditions for engineers in most territories are normal or very nearly so. The Southwest reports a scarcity of mechanical and structural men. California reports that students for summer employment are the only men available. Missouri reports normal conditions with calls for structural engineers predominating. Employers in eastern cities where usually more men are available are experiencing difficulty in finding capable engineers, with the possible exception of the District of Columbia.

The total number of positions being received by the American Association of Engineers is over 400 each month, with about 250 of these filled by the Association. This large placement is due to concerted local activity by capable employment representatives. The average monthly salary of all positions filled during June was $192. A number of positions above the $500 mark were filled.

While the general conditions are better at this time than they have been for over two years, there is still some irregularity, but the main trend shows improvement supported by prospects of further gain. Added reasons for more hopeful feeling appear in the continued increase in the operation of the iron and steel industry, the diminishing of unemployment of skilled and unskilled labor, and the active progression of building operations.

There is usually a summer letup in business, but this does not apply so much to engineering employment, for highway and municipal and other construction work is most active at this time. Authorities on economic problems are predicting that there will be considerable activity, increased production, and increased work this fall.

POLICE CHIEFS WANT WIDER ROADWAYS

Following close upon the action of the recent Good Roads Congress in Chicago which, in a resolution, declared for a minimum width of 20 ft. for highways, in deference to increasing traffic, the National Convention of police chiefs, held in San Francisco, recently adopted a resolution demanding wider streets and roads so as to facilitate the regulation of traffic. In cities like New York, Chicago, Boston, Providence, and others, narrow streets not only induce accidents but are big factors in traffic tie-ups. A committee was appointed at the convention to work for a uniform, nation-wide code of traffic signals and regulations.

EDITORIALS

LESSONS IN COAL AND RAIL STRIKES

Whatever the outcome of the coal and rail strikes of 1922, they teach a lesson of vital interest to engineers and to the general public. That lesson is that we should develop water power to make the coal interests behave and we should develop highways and highway transport to make the rail interests behave. Legislative remedies do not seem to effect cures in industrial crises; we should place our dependence in a system of economic checks and balances.

Time was when one part of the people took sides with the miners and the remaining part of the people took sides with the operators in coal strike embroglios. A third group has appeared and it is growing rapidly in size and influence. The viewpoint of the latter group was well expressed editorially in the *Chicago Tribune* for July 31, 1922:

"We think the whole mining strike crisis is bunk, a play staged at the public expense for the profit of operators and miners alike. Perhaps we are wrong, but it is our conviction that neither operators nor mine workers' leaders are in any danger of 'breaking up' until the breaking up is arranged. When the strike has got desired results in wiping out our coal reserves and the public is ready to take coal at a fat profit to owners, then peace will come on satisfactory terms to the miners, and the curtain will ring down until the next performance. That is bringing capital and labor together with a vengeance. Only the rest of us have small reason to applaud the show. We are not very optimistic about legislative remedies for our recurrent coal troubles. But there are some important economic measures which ought to be applied. They all may be comprehended in one word, water power."

The editorial goes on to advocate the development of such great water powers as those of the Tennessee and Illinois rivers and the St. Lawrence seaway.

Strikes do not usually occur when wages are low and large numbers of men are idle, but when labor is scarce and wages are high. The greatest epidemic of strikes the country ever experienced came when wages were very high and every man who was able and willing to work had a job. If the great water powers of the country are fully developed, water power, present and ready to serve, will have a strong tendency to prevent coal crises. Coal has been able to get away with everything, including murder, because it is at present so essential. If it can be made less essential in large and important industrial districts it will lose much of its present power to inflict paralysis, deprivation and suffering on the general public.

It has been demonstrated that the federal government can not break up these crises until the "breaking up" is due to occur anyway. In this connection many press references have recently been made to the action of President Roosevelt in "forcing a settlement" of the coal strike of twenty years ago. This incident is firmly established as a part of the Roosevelt legend and for legendary purposes the best possible interpretation is made of it. While we appreciate the purpose of wholesome legends they do more harm than good when they encourage us to attempt the impracticable. Doubtless many will recall that the strike president Roosevelt "settled" continued from early May until late October. By that time, previous efforts of the President having come to naught, the operators were ready to listen to reason, the men already having obligingly consented to arbitration. The President "forced" the operators to arbitrate; obviously they were ready to be forced in view of the fact that winter was at hand, etc. It is instructive to recall, also, that that was only an anthracite strike; quite a different thing from a general coal strike. With an abundance of soft coal everywhere available anthracite was in reality a non-essential; undoubtedly this assisted in the "forcing" process. With great water powers developed all coal would sink, in its mischief making powers, to a level not far above that now occupied by anthracite in the coal industry.

What we have said about water power

and coal may be said also about highway transportation and rail transportation. The railway shopmen's strike of this year, to date, has been a very tame affair compared with what we would experience if all the men who actually run the trains should quit their jobs at the same time, as they threatened to do in recent years. The best possible check on the railroads, in fact the only practicable one as we see it, is to develop a nation-wide system of highway transportation. With adequate highways in every locality a general rail strike could be viewed by the public with such a degree of equanimity that it probably would not occur at all.

It is not held that the development of water power and highway transportation will put an end to all coal and rail crises, but such developments will give the public substantial protection against the misfortunes now arising from a suspension of coal and rail service.

We believe we have pointed out the direction in which the public interest lies and we hope the engineer will continue to lead the way thither.

BELATED RATE INCREASES

Many public utilities struggled along during the war, and for some time thereafter, at pre-war rates despite tremendous increases in the cost of everything the utilities had to buy. At length some rate increases were granted and this has so incensed the public that in some states, Illinois and Indiana, for example, there has been much talk of abolishing the state public service commissions entirely.

The trouble arose primarily from the fact that the rates were not raised soon enough; not soon enough to do justice by the utilities and not soon enough to be accepted gracefully by the public. Had the rates been increased when costs of all commodities were rapidly rising this would have been taken more or less as a matter of course by the public and a minimum of friction would have developed. But it was not until prices had started to decline that rate increases were granted and this produced a maximum of friction. The public was unable to see why utility rates should go up when other prices were declining. This is a most unfortunate situation and great injustice has been done many utilities.

We are not disposed to be very critical of the state utility commissions for past mistakes of judgment but we hope they will take the lesson of this experience very much to heart and be guided by it in future. They were too optimistic about a general decline in prices which might obviate the necessity of rate increases. The expected relief from this source did not come up to expectations.

The statisticians tell us that commodity prices are again on the increase. The weighted average of 404 commodities, which are combined to form the wholesale price index of the Bureau of Labor Statistics, has increased eight points in the past year, the figure for June, 1922, being 150 against 142 for June, 1921, both expressed in per cent of the 1913 average.

The utilities must earn a fair return on their investment or they cannot be expected to maintain adequate service indefinitely. We hope the commissions will have the courage to grant rate increases where this should be done, even in the face of adverse criticism. If rising prices now make readjustments especially necessary we hope that account will also be taken, in formulating new rate schedules, of the fact that utility rates have been, generally, too low for the past seven or eight years.

RECIPROCAL HIGHWAY COURTESY

Every user of the highway has his rights and with these rights go obligations to respect the rights of others.

A special obligation rests upon the motor truck. It is precisely because the truck is big and strong enough to crowd other forms of traffic off the highway that it must not do so, but must conform to the rules of the road. Trucks usually move slowly and, like all slow moving traffic, should keep well to the side of the road or turn out to let faster traffic pass when signalled to do so. Trucks are noisy and truck drivers do not always hear horn signals promptly, so every truck should be equipped with a mirror to warn the driver of the presence of traffic behind him. The truck driver can not afford to be discourteous as drivers of passenger cars, if prejudiced against trucks, will join the ranks of those who would keep trucks off the highways or destroy their economic usefulness by drastic restrictions of one sort or another. This point is becoming well appreciated in motor circles. Recently the Indiana State Highway Commission ordered drivers of state trucks to take a course of instruction in road courtesy before being

allowed on the roads with a truck. This policy should be adopted, also, in the case of drivers of commercial trucks. The National Automobile Chamber of Commerce has also been urging the importance of courtesy in the driving of trucks, pointing out that driver discourtesy lessens the truck's economic prestige and must not be tolerated as it creates public opinion antagonistic to highway transport.

While trucks are amply able to take care of themselves on good roads they sometimes get into difficult positions on bad roads where they are at a momentary disadvantage. In such cases the truck should be the beneficiary of highway courtesy. For example, it may not be safe for a truck loaded with live stock to turn out immediately, to let a passenger car pass, when on a narrow road with steep sloping sides. The passenger car driver should then follow the truck patiently until a place in the road is reached where it is safe for the truck to turn out.

Courteous drivers of vehicles of any kind will follow up promptly all personal injury cases regardless of who is at fault, will drive at moderate speed, will avoid taking chances, will give ample warning to pedestrians or vehicles about to be passed, will recognize the fact that pedestrians have prior rights at crossings, and will be especially watchful of children playing on the roadway.

The safe as well as the efficient and agreeable use of the highway requires that each class of highway traffic recognize the peculiar rights of every other class.

DESIGN AND CONSTRUCTION OF SIX-SPAN REINFORCED CONCRETE HIGHWAY BRIDGE CROSSING WABASH RIVER AT ATTICA, INDIANA

By H. A. Hanapel, Resident Engineer, Indiana State Highway Commission, Hazelton, Indiana.

The Adeway, an important link in the transportation facilities of the State of Indiana, crosses the Wabash river at the foot of Mill street at Attica, Fountain county. The old structure, built in 1886, consists of two pony approach spans and five through trusses, total length 804 ft. The substructure consists of stone piers.

A Heavy Traffic Bridge

On account of the large amount of traffic, both through and local, the light superstructure has been greatly overstressed and was found inadequate safely to carry the loads. The floor system, being made up of wood stringers with a plank runway, was a source of great annoyance and danger to the traffic and an item of great expense of maintenance to the county. The substructure is in fair shape, but it is evident that the foundations do not extend much below the bed of the stream, if any at all.

It was realized for a number of years by the public as well as the local officials that it would be necessary to do something in order to continue to handle the traffic safely. The matter of repairing the old structure was investigated; however, it did not appear to be economical to attempt to use any part of it. The members of the trusses were not heavy enough to permit increasing the dead load by using steel stringers and adding a concrete floor. Besides the old steel showed evidence of being crystallized and therefore unfit for further use. The entire structure had outlived its usefulness.

After due deliberation on the part of the county officials, it was decided to build a new structure on the upstream side of the old one and as near to the latter as conditions would permit. Of all of the designs submitted, the one by Mr. Wm. J. Titus, Bridge Engineer of the Indiana State Highway Commission, was accepted as being the most economical and the best suited to the natural conditions. The contract was awarded to Standish & Allen of Chicago on February 7, 1920, on a unit price basis for the sum of $272,000.

The design is a six-span reinforced concrete arch, total length 986 ft. The individual spans vary in length from 135 to 150 ft. clear opening, having a rise of 16 ft., 3½ ins., to 19 ft., 11 ins. The arches are solid, with 12-in. sidewalls and counterforts supporting cantilevered brackets and a 6-in. sidewalk. The roadway provides a 20-ft. driveway, curb to curb, with a 5-ft. clear sidewalk on each side.

Foundations

The contractor started work in August, 1920, at the east end of the structure at abutment "A." The material excavated was an old cinder fill to elevation 495.00 (low water elevation 490.00) and a coarse gravel from this elevation to the final foundation, elevation 491.00. The contractor rigged up a mule traveler at this foundation and used it to drive the Wakefield sheeting and foundation piling. A total of 88 piling aggregating 2,015.7 lin. ft. below cut off (they were allowed to

project 18 ins. into the concrete) were driven.

After completing this foundation, the mule traveler was moved out to the first pier, "B," at the east edge of the water, and open dredged the hole before the cofferdam was placed. This foundation was carried down 13 ft. below low water through hard cemented gravel and then, 117 piling aggregating 2,123.9 lin. ft. were driven through the water by means of a follower made out of a hickory pile with a 30-in. long wrought iron pipe at one end. A Vulcan No. 2 steam hammer was used throughout. After the piling were all driven, the contractor received permission to seal the hole without unwatering it. In an attempt to use a tremie, the gang made a complete failure of it and after about 10 or 12 yds. were placed, the work was rejected and the contractor was ordered to unwater the hole and remove all of the concrete poured.

The following pumps were then set up at the foundation—one 8x6-in. centrifugal, one 10-in. double suction centrifugal, and a 7-in. Nye. The first two mentioned did not work properly and the three together could not unwater the hole. A 14x12-in. electric pump was then set up and it unwatered the hole in 20 minutes. About this time the river which had been at a low stage, started rising, and the 20-ft. Wakefield sheeting was found to be too short; therefore, it became necessary to build a puddle dam 4 ft. high above the sheeting. The contractor had built the cofferdam the same size as the concrete lines of the footing, and in not driving the sheeting far enough below the footing elevation to get a foothold, a great deal of trouble was experienced in keeping the sheeting from bowing in at the bottom. This naturally caused a great deal of water to come into the hole; the bottom seepage also was considerable. After a great deal of grief along the above mentioned lines, the first concrete was finally poured January 31, 1921, with a bottom dump bucket.

In the meantime, the contractor assembled a 40-ton steam derrick at the site of the west abutment, designated "G," and started excavating about October 25, 1920. He used 10ft. Wakefield sheeting, and experienec no trouble in unwatering this hole with a 7-in. Nye pump. The subsoil encountered was a very good grade of gravel in the front half of the abutment and a poor grade in the rear half. To overcome this, 13 additional foundation piling were driven, making a total of 104, aggregating 1,746 lin. ft. The first concrete was poured with a tremie, at a great cost to the contractor, about January 10, 1921.

The steel derrick was then moved east to the last pier, designated "F." The contractor again used 20-ft. Wakefield sheeting in this hole, and attempted to carry down the excavation as the sheeting was driven and cofferdam frame settled; that is, a few feet at a time. A sandy clay was encountered from natural ground elevation, about 498.00 to elevation 478.00; below this an excellent cemented gravel was found and grade was established at elevation 477.30. The plans showed the foundation at elevation 484.00, but on account of the poor subsoil it had to be carried to the elevation mentioned. A total number of 117 foundation piling, aggregating 1,872.5 lin. ft., were driven through the water. When the hole was then unwatered, it was found that sheeting was badly bowed in on the southeast and southwest corners, but not enough to warrant rejection of the hole. This cofferdam was also built to the exact concrete lines. The first concrete was poured about April 15, 1921, and no further trouble was experienced to build up the shaft of the pier.

During the late fall of 1920, the contractor built a barge 22x52 ft. for use in handling the river piers, and equipped it with a new three-drum American hoist. This piece of equipment was not able to do much good until after the spring floods, except for light work around the extreme east pier, designated "B." However, in May, 1921, pier "C," numbered from the east end of the structure, was finally started again. The contractor had open dredged this hole about three times, and every time he was all prepared to place the cofferdam there was a small rise in the river, and the hole would completely fill up with silt and sand. The same procedure was followed in sinking this hole as in the previous ones. A total of 118 foundation piling aggregating 2,083.75 lin. ft. were driven through the water. When the electric pump was set up and the hole unwatered, it was found that the bottom of the Wakefield sheeting was bowed in an average of 2 ft. in the south half of the cofferdam. The hole was therefore rejected. Part of this situation was due to the fact that the contractor had driven eight round piling in the southwest corner to stop a leak through the sheeting. Another reason, and the more important one, was that

the bottom set of rangers was kept about 6 ft. above grade, and the fact that the sheeting did not have more than a 6-in. toehold in the gravel gave nothing to take the pressure. The cofferdam, too, had been built to the exact lines of the footing concrete.

At the suggestion of the State Engineers, the contractor drove 22-ft. steel sheeting around the south half of the cofferdam on the outside of the Wakefield sheeting, and then the latter were cut off below the bottom ranger. No further trouble was experienced and concrete was poured with a bottom dump bucket.

In the meantime, the steel derrick was moved to the foundation designated, Pier "E" at the west edge of the river. Twenty-foot Wakefield sheeting was used and driven only 4 or 5 ft. ahead of the excavation and the cofferdam was settled as the latter proceeded. The hole was kept unwatered at all times and the results proved gratifying. The final cofferdam and sheeting were in excellent shape, practically no leakage through the sides at all. An excellent subsoil of cemented gravel was obtained. A total of 117 foundation piling, aggregating 1,879.2 lin. ft., were driven and completed July 2, 1921. The hole was kept unwatered when footing concrete was poured a few days later. An interesting feature of the driving of the Wakefield sheeting in this hole was the use of a so-called Jonathan pole to guide the steam hammer. In this particular location it permitted speed, together with careful workmanship.

After the barge completed Pier "C," it was moved to the next foundation west, designated "D," the last one to be completed. The same procedure of open dredging was followed, but the cofferdam was made about 6 ins. larger than the footings, and also 22-ft. steel sheet piling was used. This hole was sunk in record time without any difficulty whatever. An excellent subsoil of hard cemented gravel was encountered. The first concrete was poured in August, 1921, with a bottom dump bucket.

Observations of Foundation Work

The footing conditions encountered were ideal in more ways than one; in practically every case an excellent gravel subsoil was encountered capable of safely holding up at least 5 to 6 tons per square foot, and the piling also were driven in excellent shape, but somewhat harder than was necessary. It was desired to have at least a 20-ton safe bearing capacity; however, it is the writer's opinion that the average is near 25. This was increased so as to be absolutely sure at all times that every pile would safely carry 20 tons. Due to the fact that most of the piling were driven through about 12 ft. of water by means of a follower, it was more or less necessary to make the thing fool-proof. Even though a cast iron cap was used, it was impossible to keep this follower in good shape because of the enormous amount of punishment it received. From a study made before and after the follower was put on the pile, it appeared that at least 20 per cent of the force of the blow was taken by it. Most of this was due to broomed ends, but a good deal was also due to the fact that the stick was not entirely rigid, that is, it had some play, and also because it could not be kept vertical.

VIEW OF SIX SPAN REINFORCED CONCRETE HIGHWAY BRIDGE OVER WABASH RIVER AT ATTICA, IND.

After the piling were all driven and the holes unwatered, it was found that the original locations had been kept very well and most of the piling were driven just about as indicated on the plan. It was found, however, that driving through water is a task that gives deceiving results and therefore requires a good deal of attention.

Piers

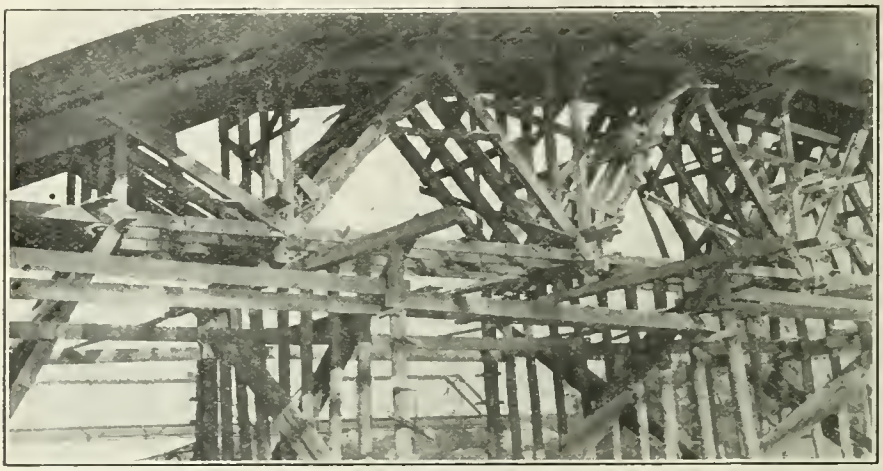
After foundations were poured, the forms for the shafts of the piers were built to the bottom of the coping, approximately 19 ft. 10 ins., and the concrete poured. After this, the coping, umbrella tops, skewbacks and 1-ft. spandrel were poured in one operation. Sufficient keyways and horizontal surfaces were left on the top of the skewbacks in the counterfort locations, and this was also finished on top to give drainage to the intakes of three 4-in. cast-iron pipes that discharge into the river on the sides of the pier. It was found to be a very difficult task to build the umbrella tops to the correct lines and grades; therefore, after three complete caps had been poured with nongratifying results, it was decided to get the centering adjacent to the piers in position first, and then it became a more easy matter to build the forms and hold them.

Arches

Before all of the foundation work was complete, the contractor had started the driving of the false-work piling for the arch centering. Those on the east side of the river were driven with a mule traveler, the barge drove those in the river and the steel derrick those on the west bank. The centering for one-half of each arch was laid out in the yard, marked and cut, and, therefore, was in good shape to put into position. This centering was designed so that it would not act as a truss, but, instead, to transmit the load directly to each pile bent, which was at about 22-ft. center.

It was decided to pour the south half of the arches first, thus putting in a longitudinal construction joint through the center line of the bridge. In addition to the great amount of transverse reinforcing steel, a large number of keyways were put in on the vertical surface of the joint, which assured that the two completed halves would act as a unit.

The first two halves on the east side were first poured, the last two on the west end next, and the two intermediate followed soon after. It was found that there was some settlement, the maximum being about 2 ins. in each case. Some of this was due to the joints of the centering tightening up and more of it to the settlement of the piling.



CONSTRUCTION VIEW OF ATTICA BRIDGE SHOWING ARCH CENTERING.

A longitudinal keyway, 4 ins. wide and 3 ins. deep, was put in the extrados of the arches, flush with the inside of the spandrel walls, and sufficient keyways were placed in the base of the counterforts to take the shear caused by the thrust of the earth fill against the spandrel walls. In each case, that part of the curb and gutter and the few cantilevered brackets over the crowns of the arches were poured the day following the pouring of the arches, so as to insure a bond between the two pours. The intermediate 12-in. spandrel walls, including curb and

gutter and cantilevered brackets were poured later.

An expansion joint filled with a ¼-in. tarred felt was put in between spandrel walls over the arches and those over the piers; a construction joint was put in between the outer edge of 8-in. curb and sidewalk, and the top of every second cantilevered bracket at the point where the sidewalk joints were made, was painted with a water proofing compound. This was all done to permit proper expansion and contraction due to the rise and fall of the arches.

After the south half of the arches were poured, the question of proper lowering of the centering came up, and it was decided that due to the fact that the entire structure acted as a unit, it would be folly to attempt to release the centering of one arch until the other ones were ready to take their share of the load. The contractor, therefore, was permitted to strike the centering of an arch 30 days after it was poured, provided the adjacent

this centering as a unit for the north half of the structure. It was therefore built very substantial and solid, and no trouble was experienced in dragging it into position. This was done by placing 4-in. rollers under each panel on the top of the pile caps, and then pulled into position by means of three crabs fastened to the ends and centers. Great care was exercised to see that entire centering was moved evenly and at the same rate of speed. It was then jacked up and wedges placed underneath. The lagging was permitted to extend 2 ft. beyond the construction joint at the center line of bridge and then jacked up as tight as possible against the intrados of the arch. The outer end then was brought up about ¾ in. above this elevation. This was done to take care of uneven settlement caused by the fact that the end was not jacked up as tightly as the part next to the arch already poured.

It is interesting to note that the final joint between the two halves came out

CENTERING IN POSITION TO POUR NORTH HALF OF ARCH, SPAN NO. 1, ATTICA, IND., HIGHWAY BRIDGE.

one had been poured 30 days, the second one two weeks and the rest at least one week. This procedure was then carried out.

The lowering was done by means of 12-in. hardwood wedges that had been placed under the centering on the top of the pile caps. In some cases, the center wedges were lowered first and the work proceeded towards the two ends; in others, it was done from the ends towards the middle. No advantage was discovered in the use of either method; however, the greatest care was taken at all times to lower the entire centering gradually. The wedges under several arches were found to be very tight, due to contraction of arches caused by cooler weather.

It was the contractor's plan to re-use

even, which indicates that there was little settlement. It was thought that the use of the centering the first time would tend to compress the timber and bring the joints up so tight that there would be no give at all the second time, so this proved to be about the case.

The same procedure was followed on all of the arches, and at no time was there any hint of grief in re-using the centering as described.

Concrete Plant

On account of contemplation of winter construction, it was decided to store a sufficient amount of the aggregate to last during the winter months when the local gravel plants suspend operations. The plant mix aggregate was bought from the Carmichael Gravel Co. and the Neal

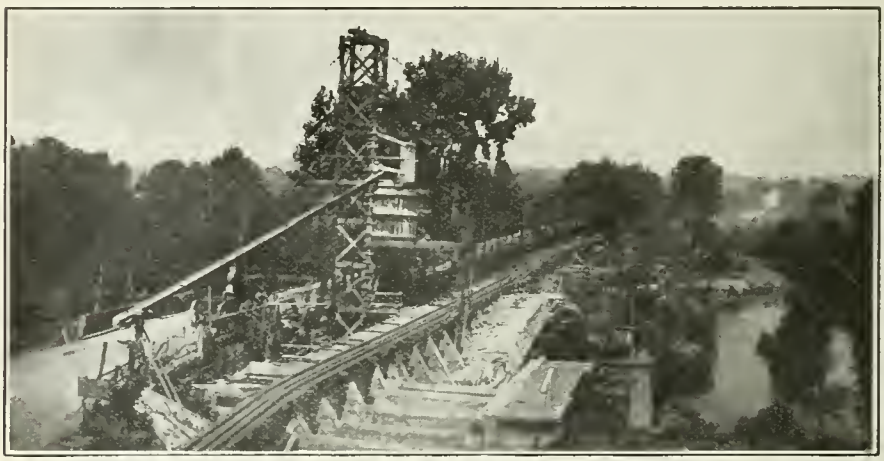
Gravel Co. located two and three miles, respectively, south of Attica on the Covington-Attica branch of the Wabash railroad. The material was shipped to Attica at the rate of six cars per day, and spotted on the track nearest to the bridge site at a distance of 1½ blocks from the east end of the existing and proposed structures, at the point where it was decided to build the stock pile. The material was hauled to the stock pile in bottom-dump wagons. By means of a snatch team and a careful sloping of the approach, the pile was carried to a height of 20 ft. At the time the pits ceased operations on Dec. 21, 1920, about 110 cars of aggregate had been delivered.

The concrete mixing plant was arranged to take advantage of the natural conveniences. A 250-cu. yd. capacity bin was built under the approach span of the old structure. Three openings were made in the floor of the north side of the span and were so arranged that the traffic could safely pass over them when they were closed. The doors were made of a ¾-in. iron plate, to which was bolted a plank flooring. These horizontal plates ran over short sections of gas pipe placed on 4-in. centers, and it therefore required very little effort to manipulate them.

The material was reloaded from the stock pile into bottom dump wagons by means of an "A"-frame traveler with a 60-ft. boom, equipped with a ¾-yd. clamshell. It was dumped directly from the wagons into the bin through the openings in the floor of the old bridge. The sloping floor of the bin was built with a false bottom through which steam coils passed, beginning at the top and running longitudinally back and forth to the bottom, where a valve was placed for drainage purposes.

In cold weather, the steam was turned on the evening before concrete was to be poured, and by morning the material was very hot, decreasing in temperature toward the top of the bin away from the coil.

It was found necessary to keep several men in the bin to keep the coarser material from separating from the finer, and thus the entire mass was thoroughly intermixed and it was possible to keep the concrete at an average temperature of about 70 degrees. The moisture found its way to the bottom of the bin and seeped away.



CONCRETE PLACING PLANT ON ATTICA BRIDGE CONSTRUCTION.

In the spring of 1921, this entire bin collapsed, and for the remainder of concreting, aggregate was simply dropped under this approach span as it was delivered and worked to the opening and the mixer by hand.

The aggregate passed through a vertical sliding gate into the measuring hopper. Two compartments, each containing the proper amount of cement for the particular class of concrete to be placed were built above and to the side of the measuring hopper, and by means of vertical sliding doors the contents of either compartment were discharged on the top of the gravel. From the mixer, the concrete passed directly into a bucket on an 80-ft. tower, from where it was distributed to different points as described later.

In the summer of 1921, the contractor built another concrete plant at the west end of the old structure. The aggregate was dumped through the floor of the old

bridge and carried to the mixer by a wheelbarrow gang. A 60-ft steel tower was used to chute the concrete to the forms.

Method of Transporting and Placing Concrete

The foundations and parts of the shafts of the piers were all poured from the old structure. Trucks, with a hopper built on the frame, were loaded under the chute at the east end of the old structure and transported the concrete where needed, and it was then carried to its permanent position by means of chutes from the old structure. Later on, after the south half of the extreme east span was completely poured (including arch, spandrel walls and sidewalls), a narrow gauge track was laid directly over the wall. The concrete was then dumped from the tower into a hopper directly over the track from where it was loaded into side dump cars and hauled with a dinky gasoline locomotive. A temporary track was laid over the arch ahead to be poured and the concrete was deposited by means of chutes. As soon as the span was entirely completed the track was laid as on the first one. In this way the work progressed through the third arch. The last three had in the meantime been poured from the mixing plant on the west side of the river. In cases where the concrete could not be handled with a chute, it was brought to a centrally located hopper and carried into position by means of buggies on a temporary platform built over the arch. The narrow gauge track was built clear across the bridge as soon as the spandrel walls were complete, and was utilized to transport all of the concrete for the south half of the structure.

Backfilling Over Spans and Building Approaches

After the steel derrick completed its part of the foundation work it was moved to the west near the extreme west abutment and started backfilling around the abutment and also the west approach taking material from a borrow pit on the upstream side of the new bridge. About 6,000 cu. yds. of material were obtained in this way. This borrow pit had been donated by the local merchants in order to get away from using any part of the old fill for the new one, and thereby at some time or other shutting off the traffic into town from the west.

An additional 6,000 cu. yds. were required to complete the west approach, about 5,200 over the bridge proper and about 700 in the east approach. The contractor decided to use the gravel in the river, and permission was given him to do so. He was then asked to fill in over the arches in such a way that the load would be evenly distributed along the entire length of the bridge.

A mule traveler was set up over the pier at the west edge of the water, and it dipped the gravel out of the river from the north side of the bridge and loaded the hopper cars, which were then hauled away with the dinky locomotive. The barge in the meantime relayed the material from farther up stream to a point where the mule traveler could reach it. The material was a well graded gravel containing about 30 or 40 percent sand, and was well suited for this purpose.

In this manner the filling was brought up in successive layers along the entire length of the bridge, and the approaches were also completed. However, the mule traveler had to be moved to the next pier east on account of the fact that the gravel was becoming unavailable in this location. The barge had to relay the material about three times, and then, even working 24 hours per day, could not keep up. On account of possible danger to the permanent structure, the contractor was not permitted to remove the material below the bottom footing course, 4 ft. above grade.

The mass of the filling was done during the winter months of 1921-1922, and most of the material froze when it was deposited. No ill effects of this were ever noticed, however, due to the fact that this was not all completed until warm weather set in, which gave the contractor an opportunity to take care of all of the settlement when the frost came out.

On account of the new approach covering part of the old one, it became necessary to shut off traffic for three days while this part of the fill was being completed. Traffic was finally permitted to cross March 9, 1922. Some little doubt was experienced about the possibility of this clean washed gravel packing, but after two weeks it became evident that the fears were groundless. A test made four weeks later showed that gravel was packed so hard for a depth of 8 ins. that it was impervious to water. Part of the success in maintaining traffic was due to the fact that a 4-wheel drive Nash truck was first taken across and made a two-way traffic path, and subsequent vehicles followed these same ruts and gradually packed the roadway.

Organizations

The work was done under the super-

vision of William J. Titus, bridge engineer for the Indiana State Highway Commission. H. A. Hanapel was resident engineer. Standish & Allen, of Chicago, were the contractors. Mr. A. Cross, of Columbus, Ohio, was in charge as general foreman the last year the work was in progress. Mr. S. Standish was the engineer in charge for the contractor, and later was made superintendent.

DESIGNING CONCRETE SHORE WALLS

By A. W. Consoer, Consoer Engineering Co., Consulting Engineers, Marquette Bldg., Chicago, Ill.

A problem that is often presented to municipal engineers is the construction of a concrete wall as a protection to the shore of a lake or river. Such walls are commonly referred to as sea-walls, although that term is a misnomer when applied to a wall to be built midway between the Atlantic and the Pacific.

The writer has examined a great many walls of this kind in front of properties on the inland lakes of northeastern Illinois, and has found many of them in bad condition. In the Spring when the ice goes out with the high water, accompanied sometimes by strong winds, walls that have not been properly constructed fail to withstand the destructive effects of wind, ice, and water, and are ground up into fragments of concrete.

A frequent cause of the failure of a concrete shore wall is a foundation that is not carried deep enough to insure the stability of the structure. In the writer's practice it has been found that foundations which do not rest on rock should be carried at least 4 ft. below the adjoining lake or river bottom. Where there is danger of undermining, the foundation should be carried even deeper or should rest on timber piles. Where the footings rest on a stiff clay, hardpan, or cemented gravel, no piles will be needed ordinarily if the foundations are carried 4 or 5 ft. below lake bottom. Wet sand, however, flows unless confined in some way, and may be subject to undermining. Holes 5 to 10 ft. deep in sandy river bottoms, due to local "scour," are not at all uncommon, and where such a sandy subsoil or other soft foundation material is found, the desirability of using a pile foundation should be considered. Wave action on inland lakes may undermine walls built on sand without piling. If a good subsoil is not found 4 ft. below lake bottom, it is sometimes cheaper to go 2 or 3 ft. deeper rather than to drive piles. In such cases hard bottom can be tested for by thrusting down a reinforcing rod or preferably by sinking test holes. In the case of walls built on solid rock it is advisable to blast out a trench about 12 ins. wide and 12 ins. deep, in order to key the wall into the rock.

The solid concrete wall is used more frequently than a reinforced concrete wall, although the latter type is often more economical. A solid wall must be so proportioned that the resultant of all forces acting on the wall, including the weight of the concrete, the pressure from water, waves, ice, and wind, and the earth pressure of the backfill will fall within the middle third of the base. The wall must be designed to resist crushing at the outer edges, and the safe bearing value of the subsoil must not be exceeded. The wall must also be safe against sliding along a horizontal joint or on the foundation, and safe against shearing along any section, but in the case of a concrete wall this is a very improbable cause of failure. It is not a difficult problem in structural engineering to determine the proper dimensions for such a wall under any given conditions, but unfortunately most of the walls that have been observed by the writer have not been designed at all, and illustrate the importance of constructing such walls in accordance with the principles of masonry design. It has been the writer's observation that more shore walls fail or show signs of poor construction than stand up as they should. This is due usually to shallow foundations, but often to scanty design. Before undertaking the construction of a shore wall, the contractor should protect his own interests and those of the owner by insisting that the wall be designed by a structural engineer, or else make his own design in accordance with the principles given above. In several states the law requires that structures of this kind be designed only by licensed engineers.

A transverse contraction joint should be provided at intervals along the length of the shore wall. The joints may be placed about 25 ft. apart and should be of the tongue and groove type. Where it is necessary during construction to leave a horizontal joint in one of these 25-ft. sections, a timber 12 ins. wide and 6 ins. thick should be laid the entire length of the course and imbedded in the concrete, and removed only after the concrete has set. The surface of the joint should then be cleaned and painted with

a thin mortar before concreting is resumed. This type of horizontal joint is needed particularly where there is likelihood of ice flows. In certain cases it is advisable to strengthen a horizontal joint of this kind by inserting dowel bars. This is frequently done when the footing is built first and the balance of the wall later, in order to make the junction between the wall and footing secure against a failure by sliding.

A shore wall must withstand some very definite forces and must be of the best construction to resist their destructive effects. In general the quality of the construction should be the same as that required for first class reinforced concrete bridge work.

NEW ROAD OIL SPECIFICATIONS FOR ILLINOIS

By H. F. Clemmer, Engineer of Tests, Illinois Highway Division, State House, Springfield, Ill.

The ever increasing use of road oils in the State of Illinois has prompted a considerable amount of laboratory investigation and practical research, and results of which have done much to enable the highway department to prepare its new set of road oil specifications. As a great many factors have bearing upon the satisfactory use of these oils, specifications covering the quality of the material have in the past been only a means of rejecting the poorest of grades. The present specifications are expected to do considerable in bringing about the oiling of roads to a better advantage insofar as economy and service are concerned.

Extent and Cost of Road Oiling in Illinois in 1921

The oiling of roads in this state has passed the embryonic stage where the expense and results are not to be considered. In 1921 there were 7,000 miles of roads oiled in Illinois at a total cost of approximately $1,500,000. Over 25,000,000 gals. of road oil were used in this work. The cost of this material amounted to about 5 cents per gallon delivered, with the cost of application amounting to 1 cent per gallon. The average cost of oiling a mile of road in 1921 ran between $200 and $250.

Increasing Public Interest in Oiled Roads

Increasing public interest in oiled roads has created a demand for more information relative to the best methods of applying oil, the comparative merits of different kinds of oil, and the types of oil to be used on various kinds of soils. The great lack of uniformity in applying oil to roads has been the subject of considerable discussion for some time, and investigations in this as well as other problems relating to the use of oil are wanted. The Illinois Highway Division has recognized this want and has made considerable progress in the investigational field. A far greater number of experiments are now being planned and will be executed within a short time. The University of Illinois has also come to the same conclusions and consequently is planning extensive investigations in road oils. Under the direction of the Engineering Experiment Station a 12-mile experimental road has been provided upon which various problems attending the oiling of roads will be taken up.

Trend in Illinois Is Toward Heavier Oils

During the past few years, the laboratory of the Division of Highways has tested several thousand samples of road oil and has collected much valuable information regarding the quality of oils from various sources, and results obtained from their use under various conditions existing in Illinois. The activities of the laboratory through its testing and work in preparing specifications has had the result of gradually improving, both in respect to uniformity and quality, the oils which are being used in this state. The most noteworthy feature of present road oil practice in Illinois is the tendency toward the use of heavier oils. A few years ago practically all oil used contained between 40 and 50 percent asphaltum, heavy oils being considered unsafe or unsatisfactory to use. Figures compiled by the laboratory show that during 1921 70 percent of all oil used in the state was purchased to contain 50 to 60 percent asphaltum, 16.5 percent to contain more than 60 percent asphaltum, and only 13 percent to contain less than 50 percent. Recognizing this condition, the laboratory has prepared the following specifications, and it is probable that practically all oil purchased in the state during this season will be purchased under these or very similar specifications.

Specifications for Oil for Earth Roads

Specifications E-1

(These specifications admit Mexican and similar asphaltic base petroleum residuums. Semi-asphaltic base petroleum when refined by certain processes may yield residuums meeting with these specifications.)

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:

2. Specific gravity 25°/25° C. (77°/77° F.), not less than 0.930.

3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.

4. Loss at 163° C. (325° F.), 5 hours, not more than 25.0 percent.

5. Total bitumen, not less than 99.5 percent.

6. Percent of total bitumen insoluble in 86° B. naphtha, 7.0 to 18.0.

7. Flash point, not less than 80° C. (170° F.).

8. Percent of residue at 100 penetration, 50 to 60.

Specifications E-2

(These specifications admit petroleum residuums refined from petroleum from Texas, Louisiana ,Oklahoma, Kansas, Illinois and other semi-asphaltic petroleums. Oils meeting the requirements of Specifications E-1 will be acceptable under Specifications E-2.)

1. The road oil shall be homogeneous and free from water. It shall meet the following requirements:

2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.900.

3. Specific viscosity at 40° C. (104° F.), 25.0 to 75.0.

4. Total bitumen (solubility in carbon disulphide), not less than 99.5 percent.

5. Percent of residue at 100 penetration, 50 to 60.

6. Flash point, not less than 80° C. (175° F.).

Specifications E-3

(These specifications admit either asphaltic base or semi-asphaltic base petroleum residuums of a heavier grade than covered by Specifications E-1 and E-2.)

1. The road oil shall be homogeneous and free from water. It shall conform to the following requirements:

2. Specific gravity at 25°/25° C. (77°/77° F.), not less than 0.930.

3. Specific viscosity at 100° C. (212° F.), 2.0 to 6.0.

4. Total bitumen, not less than 99.5 percent.

5. Percent of residue at 100 penetration, 60 to 70.

Tests of the physical and chemical properties of the road oil shall be made in accordance with the following methods:

1. Specific gravity—U. S. Dept. of Agriculture, Bulletin 949, Test No. 19, p. 36.

2. Specific viscosity—U. S. Dept. of Agriculture, Bulletin 949, Test No. 27, p. 44.

3. Loss on heating—A. S. T. M. Standards, 1921, Serial Designation D6-20, p. 731.

4. Total bitumen (solubility in carbon disulphide)—U. S. Dept. of Agriculture, Bulletin 949, Test No. 20, p. 38.

5. Naphtha solubility—U. S. Dept. of Agriculture, Bulletin 949, Test No. 22, p. 40.

6. Flash point—U. S. Dept. of Agriculture, Bulletin 949, Test No. 24, p. 42.

7. Percentage of solid residue of 100 penetration—U. S. Dept. of Agriculture, Bulletin 949, Test No. 28, p. 45.

Specifications E-1 and E-2 may be considered as alternate specifications covering oil for cold application or which would require only slight heating. Specifications E-3 admit oil of a somewhat heavier grade than covered by the E-1 and E-2 specifications. This grade is best suited for hot application on soils of a somewhat sandy nature or on roads which have been previously treated with a lighter oil.

PLANT INSPECTION NECESSARY TO INSURE GOOD BITUMINOUS PAVEMENTS

By Francis P. Smith, Consulting Paving Engineer, 131 East 23rd St., New York, N. Y.

I think it is a fair statement to make that any one who has thought of this subject, and is familiar with the various processes of construction, regards it as an axiom that plant inspection *is* a necessity to insure good bituminous pavements. It is a fact, however, that in all highway organizations there are a number of officials and engineers who have not made a special study of bituminous construction. An engineer in a great many cases is regarded as a high light, as a sort of tin god, by his constituents and is supposed to be a jack of all trades—and has to be in order to hold his position—and the multiplicity of his duties leaves him but little time to specialize in any one direction.

The Temptation to Neglect Plant Inspection

Let us assume, for the minute, that we are in the position of an engineer who has not specialized in bituminous construction. Certain contracts have been let in his district for asphalt pavements. His appropriation is more or less limited and perhaps he is doubtful as to the real necessity for plant inspection. After the foundation has been laid and is ready for the bituminous top, he visits the plant. He finds it in operation apparently running all right, the batches being turned out and the sand assembled and fed to the dryers and the trucks are

leaving with fair regularity and the mixture looks all right. It is black and the sand seems to be fairly well coated. He takes a sample from the load and tests the temperature and finds it comes within the limits of the specification requirements. From there he goes to the road, where he finds the trucks delivering the hot asphaltic mixture. It is being shoveled, spread and rolled in good workmanlike manner and he comes back to his office and thinks: "What real necessity is there for an inspector at the plant? Everything seems to be going all right, and why visit the plant more than once a day and the street occasionally? Why is not that sufficient?" He lets it go at that, and if he is fortunate enough to get a good pavement he is likely to come to the conclusion that plant inspection is not a necessity but a more or less expensive luxury which can be omitted when appropriations are scanty. There is another side to the question, however, and as I firmly believe that it is true that we learn more from our own failures and mistakes than from any other source, I am going to cite certain failures which were wholly due to inadequate inspection as possibly the best way of emphasizing the point which I am here to make.

Lessons from Three Failures

Fortunately for my illustration, within the last three years three failures of bituminous pavement have come to my attention. In all of these cases it happened that I was entirely familiar with the circumstances attending their construction and the kind of materials used and the personnel of the contractor and the engineers under whose direction these pavements were laid.

In Case I the engineer decided to limit his inspection to daily visits to the plant and street, supplemented by a daily analysis of a sample taken when he visited the street. Instead of a complete analysis he determined the bitumen content only, on the theory that the amount of asphalt that went into a bituminous road was one of the most important elements to check up, and that as the asphalt was the most expensive ingredient of the pavement he would be more likely to find a shortage there than in any other constituent. In this instance he was drawing on his experience in concrete construction work.

In Case II the engineer decided against complete inspection, but he or one of his assistants took a daily sample of the mixture and had a complete analysis made of it.

In Case III the engineer was convinced of the necessity of plant inspection and assigned a good inspector to cover the plant and had daily complete analyses made of the mixture, but he thought the street gang could get along all right. This case is perhaps outside the limits of my subject but seems to me of sufficient importance to warrant the liberty of including it.

In Case I a single sand was used and this sand had been examined carefully and approved as suitable for the construction of a sheet asphalt pavement. In Case II two approved sands were used and they were supposedly mixed in the proportions designated by the engineer. In Case III only one sand was used and there was practically no street inspection and the street gang was composed of unskilled and incompetent men. Still keeping the preliminary conditions in mind, let us inspect these roads after they have been completed and subjected to traffic for various periods of time.

The First Case

In the case of the first road, the time will be four months. We find a small portion of it in excellent condition, a part of the remaining portion is scaling badly, and the balance of the pavement is both wavy and scaly. Remember, please, that this is only four months from the day this pavement was laid. This is no theoretical case.

Now, what really happened was this: An examination of the pavement from the different portions of the street showed very clearly that the portions of the pavement which were in fairly good condition carried about the normal percentage of bituminous material. The portions of the pavement that were scaling, instead of carrying between 10.5% and 11.5% bitumen, carried on the average only 8.5%. The portion which was "shoving" had about 9% of bitumen. The analyses made by the engineer of this pavement all showed a bitumen content running between 10% and 11% and, as you will recall, these samples were taken by the engineer on his daily visits to the street.

It developed on further investigation that owing to the pressure of other work, the engineer regularly paid a visit to the street between 10 and 11 every morning. Therefore, the men at the plant and the men on the street, after that visit between 10 and 11, knew there would be no further visits made that day, and no other samples would be taken for analysis. It was very easy, therefore, for them to run during the early portion of the day a mixture which contained the normal per-

centage of bitumen regardless of what they did afterward.

It was also the case in this particular pavement that the contractor to whom the job was awarded was a man who had had a good deal of experience in public work, a man who stood very well with the administration, but this was his first attempt to lay a bituminous pavement. He was brought up in a school where anything to increase the output of the work could very often be gotten away with and such methods often did not seriously damage the final result, and being ignorant, he had to rely on the advice of the men he had hired for the job on the street and at the plant. They tried to make a low cost record for themselves by saving asphalt when they thought it would not be detected and by speeding up the plant.

The deficiency in bitumen was one of the causes for the failure. Another cause was the fact that the pavement was insufficiently compressed, the rolling was done superficially, and the finished pavement had a density of between 1.85 and 1.89, which is much too low. An examination of certain portions of the pavement which were defective showed that not only was the bitumen content low, but the grains of sand were insufficiently coated. That led to an investigation of the record as to the daily output of the plant.

The plant had an ordinary 9-cu. yd. mixer which turned out a batch of 1,000 lbs. of material. The specifications, backed up by the requirements of good practice, called for at least one minute's mixing in the mixer, the revolutions of the shafts between 60 and 80 per minute. An experienced mixing crew, trained to the last minute and entirely competent, can probably turn out one batch of mixture every minute and 20 seconds and give a full minute's mixing to each batch. An exceptionally well-trained crew can, throughout the day, average one batch in 1 minute and 30 seconds. Giving the contractor the benefit of the doubt and assuming his crew to be an exceptional one, that would make 40 batches an hour. A thousand-pound batch will lay 5 sq. yds. of 2-in. pavement, so the maximum output which could be allowed to a contractor doing his work properly and giving it the required time of mixing, would be 200 sq. yds. per hour. In this particular case the work was prosecuted with a 9-hour plant day. That gives us 1,800 sq. yds. per day as the maximum output for that plant. We found on investigating the records that 2,500 or 2,800, and even as high as 3,000 sq. yds. had been laid per day, which meant that the mixing was cut fully in half. That accounted for the insufficient coating of the sand grains. That, combined with the lack of rolling and the low percentage of bitumen, accounted entirely and wholly for the failure of that pavement in four months.

The traffic on that road was heavy. The foundation was of concrete 8 ins. thick and the subsoil was properly drained. There was no question of improper foundation or improper drainage. Further investigations involving a pretty close approximation of the daily amounts laid and their relative service records after the four months showed, in those cases where it was possible to trace them, which was about 30% of the time, that the pavement laid in the period from early morning up to 11 o'clock have given very good satisfaction. That illustrates as plainly as words can tell, what took place after the engineer had paid his daily visit and the contractor felt himself free from further supervision for the balance of the day.

An inspector at the plant would have verified the weights of the mixture. He would have verified the time allotted to mixing. He would not have permitted them to reduce it and the mixture sent to the street would have been of uniform bitumen content and his temperatures would have been properly maintained. The cost of that inspector at the plant, weighed against the indirect cost to the city through the inconvenience to the public while taking up and replacing that pavement, and the cost of a new pavement which will fall directly on the contractor, would have paid for ten inspectors at the plant ten times over.

The Second Case

Now let us visit the second road. In this road two sands were used: one a coarse sand, and one a fine sand. In the fine sand the particles were almost wholly composed of quartz. They were very sharp and had rough surfaces to which bitumen adhered well. The coarse sand was partly rounded, and if used by itself would not have made a stable mixture. It was, however, the only coarse sand available in that location at anything like a reasonable cost and not more than 33% of it was required in the mixture. A mixture made according to these proportions would have had sufficient stability and was in all respects an excellent mixture.

In this case you will remember daily samples were taken by the engineer on the street and the analysis that was made

involved only the bitumen content. The contractor was a man who had had very considerable experience in the laying of sheet asphalt, a man of high business honor and integrity and he tried honestly to lay the best pavement he knew how. The plant foreman was very good in some respects but slack in one particular. That one particular was fatal. Two years after that street was laid, possibly one-half of the pavement was in good condition and the balance was waving badly.

The cause for the defective portions of the pavement was clearly traced to lack of care in the mixing of the sands. The established proportion for the sands was 2 of fine to 1 of coarse. Now, if you have had experience with asphalt plants, especially at the start of a piece of work, you will realize how very difficult it is to get men to keep their coarse sand piles separate from the fine sand piles and establish a system whereby the sands will be mixed in the right proportion. In this particular case the coarse sand was very much cheaper than the fine. The plant foreman, thinking to do his employer a good turn and reduce the cost to him of the pavement he was laying, tried to use all the coarse sand possible. That policy was carried so far that possibly one-half of this pavement was laid with all coarse sand and no fine sand in it.

The analyses showed that the bitumen content of that pavement ran uniform. The men on the mixer did their duty, using the same amount of sand and the same amount of filler and they kept the mixture uniform in these respects and the engineer congratulated himself that this pavement was more uniform than the average and he expected the best results from it. When we have a pavement with a given bitumen content composed of a large aggregate we have one in which the surface is more thickly covered with bitumen than in a pavement of the same bitumen content which is composed of a fine aggregate. In this particular case, when using the coarse sand alone, the mixture containing 10.5% bitumen probably carried over 1% excess of bitumen, which was further aggravated by the fact that the rounded grains had a comparatively smooth surface. The result was a pavement which markedly lacked stability and under heavy traffic became wavy and shoved badly. In this case, the entire failure was due to improper mixing of the sands. An inspector at the plant who was competent and faithful would have kept an eye continually upon the men who were feeding the sand to the drum and would have seen that the coarse and fine sands were mixed in the proper proportion. Had he done so, that failure would not have occurred.

The Third Case

In the case of the third highway, which again was a main trunk line route, it also had a 6-in. concrete foundation and a subgrade more than ordinarily well drained, and only one sand was used. An inspector was present at the plant who was in every way competent. The analyses were complete and showed a mixture with a variation that was well within the average limits of departure from the standards set by the specification. In other words, the mixture was better than the average. The portions of the road that were laid in the early part of the season, showed at the end of two years a very decidedly wavy condition. Portions of the road which were laid toward the latter part of the season were as perfect at the end of two years, if not better than the day on which they were laid.

Here was a case where the mixture was not at fault, but what happened was this: In the early season the contractor had difficulty in getting a competent gang for the street. He had a poor roller man. He also had a four-mile haul from the plant and the men who shoveled the material after it was dumped from the wagon were untrained, and rakers and shovelers trampled upon the mixture while it was being spread. Complaint was made to the engineer having charge of the work of that very condition, but it appeared to be somewhat of a hardship to the contractor to expect him at the very start of the season to have a gang that was well trained and would fall into their places as they should. So, for a period of 30 days, workmanship on the street was tolerated which was not in accordance with the best practice but which would, possibly in 50 out of 100 cases, have resulted in an entirely satisfactory pavement. As is always the case, those portions of the street where the mixture had not been properly raked and fluffed up, contained places where the density of the pavement was greater than those parts immediately adjacent thereto, and when the roller passed over them, there was left a pavement which did not have the same density throughout. The compression exerted by a heavy truck is greatly in excess of that which can be obtained with a steam roller and the concentrated traffic on that particular road

found those spots that were less dense than others and began to depress them, and under modern motor traffic a depression once started quickly grows and gives rise to other depressions until a series of waves are formed, with disastrous results which are familiar to us all.

The three roads in question were paved with sheet asphalt with 1½ ins. of binder course and 1½ ins. of surface mixture. In a normal sheet asphalt mixture, a total variation of 1½ percent from the standard bitumen content desired is not necessarily fatal to the road or even extremely detrimental, so that with this type of pavement a certain amount of inaccuracy in weighing the ingredients can be tolerated without specially bad results, but in a great many sections of this country they lay what has been called Topeka mix, which is more or less of a hybrid. It was originally a sheet asphalt mixture containing a small percentage of stone. A great deal of this kind of pavement has been laid. Some of it has given very good results. In some cases its use has been justified by the fact that stone is cheaper than sand and the more stone, the cheaper the aggregate will be and the less will be the amount of bitumen required, and, therefore, a considerable reduction in the cost of the pavement will be effected. The limit of variation in bitumen contents permissible in a Topeka mixture is, however, very much smaller than that which is permissible in a sheet asphalt mixture; therefore, more careful watching is required on the part of the platform mixing gang and greater accuracy in the weighing of the asphalt and the other ingredients of the batch.

When you think of men in a cloud of dust that at times is almost unbreathable, turning out 40 batches an hour all day long, one wonders that they do as good work as they do, and it also becomes a matter of wonder how an engineer, having in charge a pavement involving 40 batches an hour separately weighed, could possibly go on without an adequate plant inspector and yet feel that the safety of the project was reasonably insured.

Temperature of Mixture

There is another point which I would like to discuss with you, which was not involved in the case of these three roads mentioned, in order to illustrate another vital reason why an inspector should always be present at the bituminous mixing plant, and that is, the question of temperature. A test of the temperature of the mixture as it leaves the plant or as it reaches the street is not sufficient. In making the mixture we have two elements which are heated, the mineral aggregate and the asphalt cement. If we overheat the mineral aggregate and have a cool asphalt cement we have in the finished product a mixture which will come within the requirements of temperature but we will have injured the mixture because the mineral particles carry only a very thin film of bitumen and if heated beyond the danger point this thin film of bitumen will harden very rapidly. If, on the other hand, the sand or stone has been saturated with moisture by heavy rains, the capacity of the drum for drying and heating the mineral aggregate will be reduced. Under such conditions, a foreman anxious to turn out a large output is tempted to overheat his asphalt to offset the low temperature of his heated aggregate, thus increasing the amount of mixture of normal temperature delivered by the plant. Such a mixture will be defective owing to undue hardening of the asphalt in the kettles and the bond between the bitumen and the sand will probably be weak.

In many cases, sand, which forms 75% or more of a sheet asphalt pavement, is obtained from large pits that are operated by experienced men and they deliver a uniform supply which requires very little inspection to insure the use of suitable sand in the mixture. In other cases, the contractor frequently opens up his own sand pit. Often times stripping is required and the face of the sand pit is found stratified, fine and coarse. Sometimes it is necessary to discard a layer 2 or possibly 3 ft. deep at the top in order to get a proper grading for the mineral aggregate. The contractor hires teamsters and places a man at the pit with a scraper and he instructs these teamsters to go to a certain portion of the pit and take the sand from there. The local teamster knows that the more loads he gets, the better he will be paid, and he takes the sand from the easiest or nearest part of the pit and the consequences are that half the loads should have been rejected. In other cases, where coarse and fine sand is mixed, it is very difficult to get the contractor to keep the sands separate. The drivers are careless and dump fine sand on the coarse pile and vice versa and there is no possible way of separating and grading the sands properly and the consequence is that the mineral aggregate varies so much that it does not come within the limit of the specifications or good practice, and, even if it

does happen to fall within those limits, the variation is still so great that in order to secure the best results, the bitumen content should be varied. This it is impossible to do satisfactorily.

The asphalt cement in former days used to be made at the plant by fluxing a hard asphalt with flux, but today most of the large asphalt manufacturers send tank cars that are tested, either before they leave the plant or on delivery, and the variations in penetration are very trifling and do not require to be tested more than once per tank car delivery instead of once for every kettle filled at the plant unless the contents of the kettles are kept under heat for a very long time.

The foregoing paper by Mr. Smith was presented at the Eighth Annual Conference on Highway Engineering at the University of Michigan.

OLD MACADAM BASE FOR ASPHALTIC CONCRETE PAVEMENTS

By W. F. Reichardt, Consulting Municipal Engineer, Watertown, Wis.

There always comes a time during the practice of an engineer when he is confronted with a proposition somewhat out of the ordinary that requires economic judgment, as well as engineering skill.

The writer was confronted with just such a proposition in 1921 when serving the City of Stevens Point, Wis., in the capacity of consulting engineer. That city, like many other cities throughout the country, had constructed many miles of macadam streets, which prior to the automobile and heavy truck was an economic proposition, but after the arrival of the automobile and heavy trucks these pavements required a heavy maintenance.

Stevens Point expended several thousands of dollars each year attempting to make these streets passable, but they were unable to do so successfully. At the request of the Mayor, Hon. J. N. Welsby, the writer studied the proposition confronting this city, with the idea of taking care of the traffic at a minimum expense. After a careful investigation it was found that the old macadam was thoroughly compacted after many years of service, and that its thickness was such as to afford an excellent base for some type of permanent wearing surface. The writer recommended that these five miles of worn macadam streets be covered with a 2-in. wearing surface of asphaltic concrete, thereby saving the city the expense of excavation for a concrete base added to the cost of the base itself.

The mayor, having confidence in the ability of the engineer, accepted the recommendation but the citizens somewhat doubted the feasibility of the proposition. It is this point that I wish to impress upon my readers, which is that the average citizen is not a judge of quality when it comes to the selection of pavements, but depends much upon their cost. The fact that I was offering an economic solution caused them to entertain doubts.

And in this position an engineer oftentimes finds himself: To carry out his idea, he must simply go before the people and fight for the acceptance of his recommendation. While it would have been more profitable to the engineer to increase the cost, it was his duty to show the citizens that they *must* accept his rec-

VIEW OF WATERBOUND MACADAM PAVEMENT IN STEVENS POINT, WIS., READY FOR RESURFACING WITH ASPHALTIC CONCRETE.

LAYING TEXACO ASPHALTIC CONCRETE ON OLD WATERBOUND MACADAM IN STEVENS POINT, WIS.

ommendation based upon years of experience.

After several mass meetings the property owners agreed to accept the recommendation even though they still retained some doubt as to its feasibility.

The writer prepared open specifications for an asphaltic concrete pavement, and advertised for bids extensively, and owing to the large contract received a very attractive bid using Texaco asphaltic cement. The contractors were the J. Rasmussen & Sons Co., of Oshkosh, Wis., and they started the actual laying of the wearing surface on July 15th and completed it on September 1st, laying approximately 75,000 sq. yds.

The writer knew that this type of pavement had been used successfully in other sections of the country, but was not aware of its use in a climate of such extreme temperature as is found at Stevens Point. During the time of laying this pavement the thermometer registered as high as 102 degs. in the shade, and during the winter of 1921-22 the thermometer registered many degrees below zero for a long period of time. The frost enters the ground at this city to a depth of 5 ft., and there is always much snow and ice upon the pavement for many months of the year.

Although the past winter was extremely severe at Stevens Point, the writer on inspection learned that the pavement was not injured by this severe weather and found the pavement in excellent condition and practically free from cracks, which are generally found in this type of pavement laid on a concrete base.

In laying this type of pavement, the engineer must be very careful in preparing the old base and disturb it as little as possible. If the base is not properly

TEXACO ASPHALTIC CONCRETE ON OLD WATERBOUND MACADAM PAVEMENT STRONG'S AVE., STEVENS POINT, WIS.

treated the wearing surface will not wear well.

In this case the old pavement was reshaped and properly rolled and made ready for the 2-in. wearing surface of the Texaco asphaltic concrete, which was laid in the same manner as when laid upon a portland cement concrete base.

The writer has noticed upon inspection of these pavements that on some streets there are no cracks in the wearing surface, and he believes that these streets are even better than those in which a concrete base is used.

As there are a number of cities in Wisconsin and elsewhere in the country having many miles of old macadam streets, this type of construction will surely be popular, and any city that fails to take advantage of their old macadam for a base will deeply regret it. They must bear in mind that any engineer can spend their money, but that it is the economic solution that should receive their attention in the future.

CONSTRUCTION AND MAINTENANCE OF GRAVEL ROADS IN IOWA

By C. Coykendall, Assistant Chief Engineer, Iowa State Highway Commission, Ames, Iowa.

The type of improvement most generally practical for secondary road systems is a gravel surfacing or sand-clay surfacing. It has been found during the past ten years that this type of improvement is in general more economical than waterbound macadam and more cheaply maintained under modern traffic. It therefore follows that there is probably no problem deserving of more thoughtful consideration on the part of highway engineers than proper methods of constructing and maintaining gravel and sand-clay roads.

In this discussion no fine distinction will be made between gravel and sand-clay construction. Satisfactory results can be obtained with either gravel or sand-clay construction if available material is used intelligently. Given ideal materials, the construction of any type of road is not a difficult problem. It requires a higher degree of engineering ability to get satisfactory results from the most available sources of material, even though such materials may be generally regarded as of inferior quality, than to require ideal materials without consideration as to the availability of such materials, and the resulting construction costs.

To Pave or Not to Pave

It is extremely difficult to determine where the dividing line between the construction of pavement and the construction of gravel roads should be drawn. There are a number of factors that must be taken into consideration in making this determination. Perhaps it would be well to enumerate some of these factors.

The Amount of Traffic

First, and primarily, the amount of traffic which must be handled, either present traffic which the highway is carrying, or the traffic that we can reasonably anticipate will be handled as soon as the road is completed. No one can state with any certainty the exact number of vehicles which a gravel road will handle in a satisfactory manner. All know from experience that there are roads on which the traffic can not be satisfactorily taken care of on such a surface. Likewise all know from experience that there are roads of secondary importance where a gravel surface serves every need of the traffic. Between these two points, however, there are many situations which are not so easily classified.

During 1919 and 1920 the State of Iowa in connection with the submission of Federal Aid projects did a considerable amount of traffic census work. Some of the roads on which a traffic census was taken had failed satisfactorily to take care of traffic as gravel roads. The traffic count showed that on the road south from Spirit Lake, which is perhaps the most popular summer resort in Iowa, there was an average daily traffic of approximately 915 vehicles. This road could not be satisfactorily maintained as a gravel road under this traffic. On the Jefferson Highway north from Des Moines the traffic count showed an average daily traffic of approximately 800 vehicles. It has been found that this road could not be satisfactorily maintained either as a gravel road or with a cinder surfacing. On a project in Howard County, which is some distance from the centers of population and carries only the ordinary county seat to county seat traffic, and a very limited amount of through traffic, the traffic count showed an average daily traffic of 238 vehicles. This road has been completed as a gravel surfacing project and is taking care of the traffic in a very satisfactory manner. The same is true of a project in Chickasaw County where the traffic count showed an average daily traffic of 216 vehicles.

We have reached the conclusion in Iowa

that where the daily traffic is not in excess of 500 vehicles per day, we can quite successfully construct and maintain a gravel surface. Where the traffic is in excess of this amount, however, maintenance costs mount rapidly and we are unable to give traffic service that is comparable to the service given by a properly constructed and maintained paved road.

Availability of Road Materials

Second, availability of materials for gravel road construction and maintenance; also availability of materials for paved road construction and maintenance.

Availability of materials determines in a large measure the economical type of improvement on any road. Where a good quality of gravel is available locally for gravel surfacing work, it is economical to construct and maintain gravel roads under conditions where it would not be economical if all such material for construction and maintenance had to be transported a long distance by rail, thereby greatly increasing the cost of construction and maintenance work. The real measure of the value of any type of road is the cost per ton mile or vehicle mile to the users of the highway. In determining this cost the availability of materials is an important factor.

Relative Usability of the Two Types

Third, the relative usability of the two types of road.

In considering usability we must take into account tractive resistance, satisfaction and convenience to the users of the road, and the safety of the road. Often we are justified in paving a road that can quite economically be taken care of by some cheaper type of construction, from a consideration of these factors alone. All have had experience in driving over a gravel road where the surface was in good condition but the dust was so bad that it constituted not only a nuisance, but an actual menace to traffic. All have seen gravel roads, especially during a long-continued dry spell, where the loose gravel which had accumulated at the sides and on the shoulders constituted a real menace to travel, particularly at night when meeting or passing other vehicles.

Gasoline Requirements

Experiments carried on by the Engineering Experiment Station at Ames, during the past year show that for truck traffic, a good concrete or brick surface requires 20 to 30 per cent less gasoline consumption per ton mile than is required for a road with a good gravel surface. Similar conclusions were reached in a series of tests carried on a few years ago by Professor A. N. Johnson, now with the University of Maryland. Hence it appears that on account of less surface resistance, actual operating costs to motor vehicle users are less on a good paved road than on a good gravel road, and this with other factors that are measures of the usability of a road are worthy of consideration in determining the proper type of improvement.

The Time Element

Fourth, the length of time that must necessarily elapse before a road can be paved.

It is often economical and expedient to gravel surface a road where traffic conditions will justify pavement in order to provide the traveling public with a usable road until such time as the pavement can be constructed. The building of a system of paved highways including five thousand to ten thousand miles is no small undertaking, even after the necessary legislative action has been taken and the necessary funds for financing the program have been provided. It takes time to develop an engineering organization capable of properly handling a large paving program. It takes time to develop sources of material sufficient to take care of a large paving program. It takes time to develop a contracting organization to do the actual work. From our experience during the past two or three years, during which time a large paving program has been under way, we can appreciate the fact that few states are organized to build more than a few hundred miles of pavement each year. The demand of the public is for "usable roads now." Consequently, in many instances we are justified in producing a large mileage of relatively cheap road which will give road users service during the time that must necessarily elapse before a large mileage of paved roads can be produced.

Legislative Machinery

Fifth, legislative machinery for building various types of road.

This is really the meat of the whole situation. We can not build roads except as we are authorized to do so by our state legislatures, and are provided with the necessary funds. Consequently in states where we are not authorized to build paved roads and in which funds for financing this type have not been provided, we must build the best type of road that has been authorized and for which funds have been made available.

Referring again to the situation in Iowa,

we can not build paved roads in any county in Iowa until the voters of that county have authorized the general policy of hard surfacing the primary road system of that county. If we are to make any material progress in those counties that have authorized the paving of the primary road system, a bond issue must also have been authorized. Consequently, in Iowa we are not in position, in all cases, to build the type of road which should be built from a consideration of the needs of traffic, nor is this restriction peculiar to Iowa alone.

This discussion up to this time has dealt only with factors covering the selection of the type of improvement. We will now assume that we have a road which is to be gravel surfaced, and will give consideration to the details of construction.

Alignment, Grade and Cross Section.

In gravel surfacing primary roads the same consideration as to alignment, grade and cross section applies as in the case of paving. There are many miles of our trunk line or primary road system that should probably be gravel surfaced before they are paved. Without doubt, however, the time is not far distant when this mileage should and must be paved. Consequently in building a gravel road we should attempt to determine upon a location and prepare a design as to grade, drainage structures, and cross section, which will prove satisfactory later on when the road is to be paved. It is quite generally recognized that the maximum grade for primary roads should not exceed 6 per cent, and should be made as much less than 6 per cent as topographical conditions will justify. Horizontal curves should be held as closely as possible to a maximum of 10 degrees. Right angle turns should be rounded with a curve of not less than 200 ft. radius, while a 300-ft. minimum requirement is better. In so far as is at all possible, the element of danger at railway crossings should be eliminated, either by grade separation or relocations of the highway which will eliminate the crossings entirely. The cross section should provide a minimum from 28 to 30 ft. width between shoulders with ditches at least 2 ft. below the shoulder line, and 4 to 6 ft. out from the shoulder line. A flat bottom ditch at least 2 ft. in width should be provided and back slopes made with whatever slope is required to prevent the ditches from filling.

On secondary roads less stringent requirements can be laid down as to grade, alignment and cross section. Grades and alignment should be the best possible to secure giving due consideration to the amount of traffic the road must carry. The cross section will vary between 20 and 30 ft., the limits depending upon the importance of the road, with substantially the same requirements as to ditches and back slopes outlined above for primary roads.

Drainage

Thorough subdrainage is absolutely necessary to successful gravel road construction and maintenance. It is probably even more essential on this type of construction than on pavement, inasmuch as the road surface itself has so much less inherent strength. Subdrainage can be secured either by the use of tile or by the construction of a grade which will bring the surface of the road well above the ground water limits. In all cases the surface of the road should be at least 2 ft. above the ground water level, and as much more than this as it is practical to secure. It is generally conceded by everyone at all interested in the road program in Iowa that thorough drainage is a primary essential to successful road construction. The people of Iowa are probably more nearly in accord on this point than on any other point in connection with our road building program. In the level sections of the state where natural drainage conditions are poor we ordinarily use more than a mile of tile drain per mile of road. During the 1921 construction season we laid more than one thousand miles of tile drain.

Material Specifications

Specifications for materials to be used for gravel road construction should be broad enough to admit any graveling material which by intelligent application can be successfully used in road construction. All states are not in accord with this but as stated heretofore, we believe that it is necessary to utilize to the fullest advantage the materials that are available. The maximum size of stone should not exceed 1½ ins. If this limit is changed, we would recommend decreasing it rather than increasing it. The amount of binder which the material may contain is extremely variable. As a general proposition the less binder that is used, the better. There are comparatively few instances where it is justifiable to haul binder for any considerable distance, inasmuch as substantially the same results can be secured by incorporating the loam, clay or gumbo of the road into the surface as binder.

Amount of Material Per Mile

The amount of material required per mile of road varies, of course, with the type of road being improved. Ordinarily between 1,000 and 2,000 cu. yds, per mile is enough. More material can be added from time to time as a maintenance measure. Consequently it is not advisable to place as a construction measure so much material that it is a serious problem to traffic properly to compact the material.

Handling of Construction Work

Gravel road construction work is very readily handled as a contract proposition if the specifications are properly drawn. The construction of the grade and the installation of the necessary drainage structures and tile drainage should not be tied up to the same contract as the gravel surfacing. Neither should maintenance by the contractor over any considerable period of time be required. The items included in the contract should be as few and as definite as possible. In our Iowa specifications the contractor bids on the following items: Stripping gravel pits, shaping subgrade preparatory to receiving the gravel, loading the gravel at the pit and hauling it one mile and spreading, and additional half-mile units of haul. The stripping of pits is on a yardage basis with a specified amount of work to be done.

It has been found economical thoroughly to prospect the source of supply before contracts are awarded for gravel surfacing work. From these investigations it is possible to specify with reasonable accuracy the amount of stripping that will be required, also whether or not the material must be screened and oversized material crushed. In the average deposit where there is not a large amount of oversized material, the price bid per cu. yd for loading includes the removal of oversized material at the pit.

All hauls of less than one mile in length are included in the price bid per cu. yd. for loading at the pit, as is also the spreading of the material upon the subgrade. When the haul exceeds 1 mile and is less than 1½ miles the price bid for each additional half mile haul is added to the unit price for loading. Similarly for each additional half mile that must be hauled the unit bid is proportionately increased. This method has been found more satisfactory and less confusing to contractors than bids based on average yard-mile hauls.

Before the gravel is dumped upon the road the subgrade should be flat and smooth. The gravel should then be dumped either on the shoulders or in the center, depending upon the time of year that the work is being done, and then spread the full width of the road. The material in the center should be spread thinly enough that traffic can travel down the center of the highway without serious inconvenience, immediately after spreading operations have been completed. We have not found the use of a roller practical in gravel road construction. Our most satisfactory results are secured by allowing the gravel to be compacted by the traffic, under continuous and intelligent maintenance. By spreading the gravel so thin that traffic is forced to the center, the shoulder lines are not destroyed nor is the element of danger to traffic introduced that is present when the gravel is windrowed down the center and traffic is forced to the shoulder line. As the center becomes compacted under traffic, loose material from the shoulders is worked toward the center of the road and the road gradually assumes the cross section intended, that is, a thickness of 5 to 7 in. at the center line shouldering out to a feather edge near the shoulder line.

It is often found during the process of compacting the gravel that the material used is deficient in binding qualities. Usually this difficulty can be remedied by harrowing, plowing, or otherwise mixing the material of the subgrade into the surfacing. It is believed advisable, however, to exercise considerable discretion as to the amount of binder used. Traffic should not be seriously inconvenienced by being forced to travel for a long period over a loose gravel road, but if some patience is exercised, both by the engineer in charge of the work and those using the road, it will be found that a more successful road will result from a sparing use of binder.

Maintenance

Under the construction specifications which have been recommended, it is very difficult to state where construction stops and maintenance work begins. As a matter of fact it is recommended that the maintenance organization take over the road as soon as the gravel has been placed on the subgrade, spread once and thoroughly mixed. The success of any gravel road is dependent very largely on the maintenance. Consequently, as soon as the gravel has been placed ,a well organized maintenance crew should be in position to take over the road and give it proper attention through the very impor-

tant stage that it is being compacted by traffic.

For the gravel roads which we can economically build from material available in Iowa, maintenance by a bituminous mat coat or by the application of bituminous materials is not recommended. Many of our materials have too large a percentage of fine material to make this system of maintenance successful. In fact, representatives of commercial interests primarily engaged in the manufacture of bituminous road materials do not recommend the use of such materials on many of the gravel roads in Iowa. This discussion will be limited to maintenance of gravel roads by methods other than by the use of bituminous materials without in any way entering into the merits of the use of such materials where a different type of gravel is available for the construction work.

Gravel road maintenance divides itself quite logically into two operations: First, the maintenance of material placed during construction, and second, maintenance by applying additional material. Both operations are necessary. We must expect to renew from time to time the material which is lost either by the action of the elements or by gradually being forced into the subgrade. On our most heavily traveled gravel roads in Iowa the annual replacement of surfacing material is from 300 to 500 yds. per mile per year.

Patrol Maintenance

For keeping gravel road surfaces in good condition the patrol system of maintenance is strongly recommended; that is, a patrolman equipped with a patrol blade grader and other incidental tools should have full charge of the maintenance of a certain section of gravel road. The length of this section is dependent upon the importance of the road and the amount of traffic which it carries. For heavily traveled roads ordinarily five to six miles is the maximum which a patrolman can take care of. The surface of a traveled gravel road requires constant attention, regardless of weather conditions. The best results in filling chuck holes that develop are secured after it rains, but the prevention of the development of chuck holes is dependent largely on the care the road receives during the dry weather periods. If a film of loose material can be kept on the surface of the road, it will be found that this film of material really bears the brunt of the traffic and prevents ravelling of the surface of the road. Naturally if a film of loose material is to be kept spread over the surface, continual attention on the part of the patrolman is required, as traffic tends to whip this loose material to the center and to the shoulder lines.

Gang Maintenance

The efforts of the patrolman must from time to time be supplemented by what is ordinarily styled gang maintenance. The patrolman is not equipped to do heavy work such as opening ditches or building up the shoulders. It will be found on a heavily traveled road that from time to time an accumulation of loose material has taken place on shoulders and that it is very difficult to get this loose material to pack in the center of the road. In those cases it is often necessary really to reconstruct the road ; that is, the loose material that has accumulated on the shoulders should be forced to the center of the road, the shoulders built up from material taken from the ditches, and the gravel re-spread from shoulder line to shoulder line. For this work, a 12 ft. blade grader drawn by a tractor is very effective. It will be found in this operation that the material taken from the ditches acts as new binder, and that better success will be had in getting the gravel compacted. Quite often this process should be supplemented by the addition of a maintenance course of material. In fact, this process practically always should precede the adding of a maintenance course of material.

Gravel Maintenance of Earth Roads

We experimented in Iowa during the year 1921 with a so-called gravel maintenance of earth roads. That is, an earth road that has been properly graded and drained is given a very light surfacing of gravel—approximately 500 cu. yds. per mile. We have not considered that with this much material we have been building gravel roads, but we have been making earth roads much more usable for eleven months, at least, out of every year. The addition of the gravel to the top soil of the road makes the gumbo soil or heavy clay soil much more easily maintained under heavy traffic. It also makes the surface of the road impervious to ordinary summer rains.

The cost of this kind of maintenance where gravel is locally available is not heavy, and it is expected that on roads where a 500-yd. maintenance course was placed in 1921 an additional 500 yds. will be placed in 1922, and in time we are quite likely to have "maintained" an earth road into a gravel road. Material used for this kind of work should all pass

a screen with 1 in. openings. We are much interested in the possibilities of this type of road work and expect to try it on quite a considerable mileage during 1922.

Conclusions

In conclusion we have these points which should be emphasized in connection with the construction and maintenance of gravel roads:

First, do not lose sight of the importance of this type of construction. For years to come this type of road will undoubtedly constitute the greatest percentage of the surfaced roads that are built.

Second, make the maximum use of available materials. Have your specifications as to materials flexible enough to allow the use of any graveley material which with intelligent construction and maintenance methods can be advantageously used for gravel road construction.

Third, draw the specifications in such a manner that the construction of gravel roads is a readily contractable proposition. Do not require the construction contractar to do a lot of maintenance work for which he has neither equipment nor the experienced organization so necessary for satisfactory gravel road maintenance.

Fourth, do not expect satisfactory results from any gravel road unless thorough and systematic maintenance can be given. A gravel road is no better than the maintenance it receives.

The foregoing matter is from a paper by Mr. Coykendall, presented at the latest annual meeting of the Highway Engineers' Association of Missouri.

INGENIOUS METHODS EMPLOYED ON HIGHWAY BRIDGE RECONSTRUCTION AT MILPORT, INDIANA

Lengthening a bridge 70 ft. by adding a steel span procured sixty miles distant, persuading the contractor of a dredging project to dismantle his machine in preference to tearing down tbe bridge under which it would not pass, all accomplished at a saving of $33,000 over the cost of a new bridge equally as good, is a unique feat in bridge engineering in the state highway department in Indiana.

This bridge rebuilt through modern enginering methods, spans the Muskatatuck river at Milport, half way between Seymour and Salem, and is on state road 24. Flood waters of several seasons showed the river was too narrow, so county commissioners contracted to widen the stream by dredging.

The highway commission negotiated with the contractor to dismantle his dredger, and the department removed the dirt within the state's right-of-way. The bridge was lengthened, an action necessitated by widening the stream, by adding a span taken off a bridge on another state road near Southport.

The Milport bridge is near the famous Milport Knobs, immediately south of the river on the Salem road. This old road is identified with the history of this section when Indiana was a part of the Northwest Territory. The road is said to have been laid out by French military engineers. The old bridge was built in 1884. While in fairly good state of preservation, it would not have been practical to have re-erected it had it been necessary to raze it to permit the dredger to pass, William J. Titus, chief bridge enginer of the department, says.

In making this bridge capable of meeting traffic requirements for several years, a new floor was laid, steel work cleaned and painted, and the contractor, an Ohio firm, tightened the truss members in a most ingenious manner. A forge was placed at the center of the rods, the steel heated to proper temperature, and forced together by driving the rods from either end. The old stone abutment was removed and a new concrete pier and abutment laid to care for the additional span. The old abutment rested on hewed logs floating on soft clay, the engineers say. The new concrete pier and abutment were placed on 35-ft. piling driven to solid rock approximately 50-ft. below the water level.

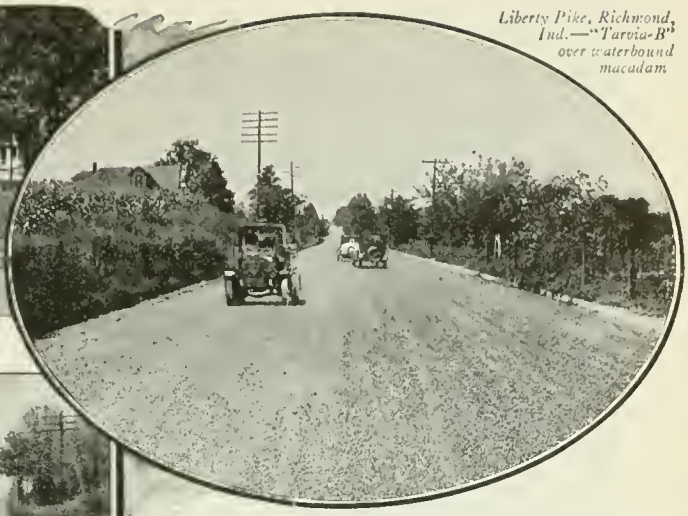
The contractor's price on repairing this project was $17,000. It would cost $50,000 to build a new bridge as serviceable, according to highway officials.

THE USE OF BLACK BASE

By Frank B. McGrane, 16 College Hill Road, Somerville, Mass.

After being forgotten for a couple of decades, asphaltic concrete base is again coming into general use. A foundation that was discarded for no apparent reason, other than the mistaken idea of the necessity of a rigid base for the asphalt

North 15th Street, Richmond, Ind.—Macadam maintained with "Tarvia-B"



Liberty Pike, Richmond, Ind.—"Tarvia-B" over waterbound macadam

Chester Pike, Richmond, Ind.—Macadam maintained with "Tarvia-B"

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"We have developed here a Tarvia treated gravel pavement which is so popular for residence streets that the demand each year is beyond our ability to construct. Observation of the service rendered by streets which have been surface treated during the past four years has convinced our people of the economy and serviceability of Tarvia for this purpose.

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pavement, is again finding favor with the engineer.

Black base that was laid 30 years ago was recently removed for the purpose of changing grade; its state of preservation was remarkable, showing absolutely no deterioration thereby exploding the theory that contact with dampness or water soon ruins a mixture containing bitumen.

Difficulty in obtaining portland cement during the war led the Engineer to resort to the first base used for the asphalt topping, the base that offered none of the objections of the rigid base. When black base was laid 30 and 40 years ago little was known of the qualities of asphalt binder for paving purposes. Today we have the benefit of many years of research on the part of some very able men.

In the laying of asphaltic concrete base the mixture should not be thought of in terms of portland cement proportions, such as 1-3-6 or 1-2-4. The percentages of ingredients will have to be determined by traffic and available supply of sand, gravel or crushed stone. The amount of bitumen is, of course, gauged by the carrying capacity of the aggregate. Proportions must not be haphazard, but weighed in a modern manner and mixed until every particle is coated unformly and a homogeneous mass is produced.

While the tendency today is to insist upon the pug-mill type mixer, which for the finer mixture is essential to good work, it may not apply to the coarse aggregate used in black base. When one takes into consideration that stone or gravel up to 2½ ins. will be used, it will be seen that considerable damage to the pug-mill type is the likely result; the breaking of mixer blades and the ripping of the mixer liner would be a common occurrence. The cylindrical or cube mixer would here be advisable in the opinion of the writer.

The question may be raised: if the cube or cylindrical mixer is not good for the top, how can it be satisfactory for the foundation? Consider the difference in the mixture and the reason becomes readily apparent.

Asphalt surfacing or topping is a mixture of fine sand and filler (which may be either portland cement or stone dust.) Such a combination possesses billions of particles in a single batch each of which must be completely and uniformly coated with bitumen. In the cylindrical or cube type mixer there is a strong tendency for the finer particles to separate and form balls after the bitumen is poured into the mixer or during the mixing process. This of course, means nonuniform distribution of bitumen among particles with consequent weakness. Again should the aggregate be below a good working temperature the bitumen will likewise be reduced to this state, and it follows that the colder it becomes the greater its cohesion and the greater the cohesion the more resistance is offered to mixing. In this condition a homogeneous mass is beyond this type of mixer, whereas in the pug-mill the heavy revolving blades churning through the mass at about 70 revolutions per minute, break up balling and overcome the cohesive resistance offered by the bitumen.

In black base the particles are many times reduced to a minimum, much less surface is to be coated and the amount of bitumen is considerably reduced. Again, owing to the reduced number of particles, the cohesiveness between particles or resistance to mass mixing is reduced to such an extent that a good batch can be obtained in the cylindrical or cube type. For best results not less than 15 r. p. m. should be reduced and mixing should continue at least 1½ minutes to the batch. Mixed material should be hauled to the job in vehicles covered with canvas or other suitable material. Upon arrival on the street or road the concrete should be dumped on a platform, never on the subgrade. This prevents the chance of mingling or mixing the soil in the material which of course would cause weakness in the structure. Should the haul be a long one the coarse aggregate will settle in transit. If the mixture is rich in bitumen this will come to the surface; when dumped on a platform the shovelers must turn the material over when depositing for the rakers who should so handle the load that no spot will contain an excess of asphalt, otherwise a soft spot is likely to result.

Rolling black base should be done with a heavy roller, preferably the 3-wheel type. Only sufficient water to prevent sticking should be used. An excess of water brings the bitumen to the surface. The reason for this is that water causes fermentation. The result of such action would mean a soft plane of contact and possible shifting of surface topping.

For a good result follow black base closely with the surface material. The best construction is obtained by laying the topping before the base cools.

WATER WORKS SECTION

NEW WATER PURIFICATION AND PUMPING PLANT AT PRYOR CREEK, OKLAHOMA

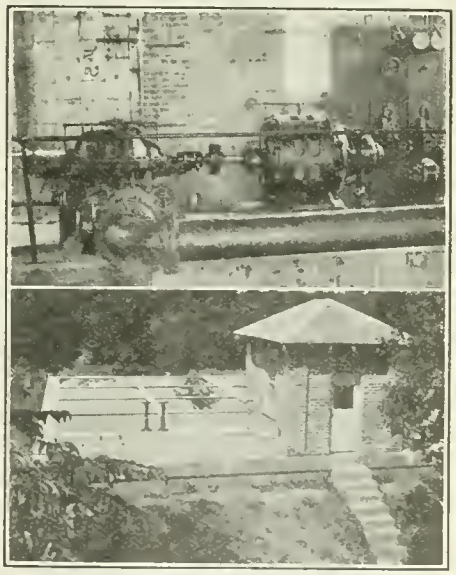
By L. M. Bush, of V. V. Long & Co., Consulting Engineers, 1300 Colcord Bldg., Oklahoma City, Okla.

The city of Pryor Creek, Okla., is located in Mayes County, about seven miles west of the Grand river, from which stream its water supply is obtained. The Grand River has a swift current and a large flow at all times of the year. There are no towns or cities of any size, which discharge their sewage into this stream, closer than Miami some sixty miles above, and due to the large flow at all times the river water is in a fair condition when it reaches the Pryor Creek Pump Station. Tests by the laboratory of the State Board of Health, have found a low bacterial content but the test has characterized the water as suspicious.

The city of Pryor Creek has a well-metered water service but a large consumption. Daily consumption averages 300,000 G. P. D. during the winter months and 400,000 G. P. D. during the summer. The M. K. & T Railroad Company purchases water from the city.

For several years, the pumping equipment has consisted of two 750 G. P. M. reciprocating steam pumps, pumping water directly from the river through pressure filters to the stand tower in town. It became necessary to discontinue the use of the steam pumping plant due to the fact that coal had to be hauled ten miles from the city of Pryor Creek and this made the cost of steam power excessive. The discharge head averages 325 ft., and the suction lift, at low water stages, is 19 ft. This installation has worked well at times when the river water was clear, but at times following rains it has been impossible properly to clarify the water, due to the lack of any provision for coagulation after the addition of coagulants to the pump suction. In extreme cases it has been necessary to wash the pressure filters every few hours in order to supply water that would be even reasonably clear. At these times the supply in town decreased to such an extent that the storage in the city was frequently very low.

In September, 1921, contracts were let for the construction of a new settling basin and the installation of motor-driven centrifugal pumping units. Power is being supplied by the local utility company over a 13,200-volt transmission line. A 500-g.p.m. low lift single stage centrifugal pump, operated by a 15-h.p. motor, pumps the water from the river to the settling basin. A 500-g.p.m. high-service three-stage centrifugal pump, driven by a 75-h.p. motor, pumps the water from the settling basin through the pressure filters to the standpipe in the city, seven miles distant. The settling basin has a capacity of 200,000 gals. and is designed for a retention period of six hours at periods of maximum consumption. The agitator consists of four compartments and wooden baffle boards. The feature of this design is the



VIEWS OF WATER PURIFICATION AND PUMPING IMPROVEMENTS AT PRYOR CREEK, OKLA.

High Service Pumping Installation; 500 G.P.M. 3-Stage American Well Works Centrifugal Pump Direct Connected to 75 H.P. Westinghouse Motor-Coagulating Basins and Chemical House.

short retention period in the agitator, being ten minutes. Powdered alum is used as a coagulant being fed to the agitator through a chemical machine having variable speeds. At the time of the test, a solution of 1½ grains per gallon, was used with very good results in clarifying the water in the basins. Another feature of the installation is the use of a manual solution feed chlorinator for adding liquid chlorine to the filtered water under 110 lbs. pressure. The chlorinator is installed and feeds into the discharge main to the city and is operated by a 3-h.p. motor.

The settling basins are constructed of reinforced concrete and are located at sufficient elevation to permit the use of gravity filters to be installed at some future time. A Pittsburg Dry Feed Chemical machine is used. American Well Works Pumps direct connected to Westinghouse motors, were purchased. A 13,200 volt, 3-phase transmission line, furnishes electrical power for operating the plant from the Public Utility Company's Power Plant in the city of Pryor Creek.

The plant was designed and its construction supervised by V. V. Long & Co., Consulting Engineers, Oklahoma City, Oklahoma. The construction work was in immediate charge of R. D. Morgan, Water Superintendent for the city of Pryor Creek. The Ajax Construction Co. of Lawton, Okla., were the contractors for the work.

FINANCIAL GAIN FROM IMPROVING OLD WATER SYSTEMS

By Lawrence W. Cox, Civil Engineer, 1102 York St., Des Moines, Iowa.

During the past year the writer has collected considerable data relative to the water supplies and water consumption of a number of Iowa cities. Many of the smaller cities were found to have supplies that were not satisfactory. At some of the cities, the supply was scanty, but of good quality, at some, the supply was abundant, but the quality of water was poor, while at other places the supply was not only scanty, but the quality of the water poor. In only a few places visited, was the supply found to be both abundant and of good quality.

The data collected confirms the fact that the per capita consumption of water increases appreciably with both the quality of the water and with its abundance. Water rates no doubt have their influence, but no matter how low the rates, if the supply is known to be scanty, muddy, highly mineralized, or otherwise poor, prospective consumers have less incentive for connecting up, and those consumers that are connected up, use less freely than they would otherwise do. On the other hand, many cities with adequate supplies of water of good quality, have good per capita consumption, even with high water rates.

Table I gives a record of ten municipalities ranging in population from 1,738 to 8,034, all within the same section of the state and all of a residential character.

Regardless of the moral obligation which city officials owe the citizens of their communities, to see that the public water supplies are sanitary, and regardless of the necessity of a copious supply in order to maintain dependable fire protection and continuous service to such patrons as are dependent upon it, it is in many instances nothing less than good business to make the necessary investments for improving their supplies. In Table I, the systems with the lower per capita consumptions, are not self-supporting, while those with the higher per capita consumptions are self-supporting or even making money. The dividing line varies of course with the investment in plant and operating costs, but is not far from 50 gals.

While it appears from Table I, that the larger per capita consumptions are among the larger cities, it is also seen that these

TABLE I—WATER SUPPLY AND CONSUMPTION IN 10 IOWA TOWNS

City No.	Population 1920	Gals per Capita per Day	Character of Supply
1.	1,738	23	Impounding reservoir, muddy, polluted water, supply sufficient for normal years only.
2.	2,193	25	Deep well, water highly mineralized, supply scanty, water rate high.
3.	1,787	26	Impounding reservoir, water coagulated with alum, not filtered, supply scanty.
4.	2,684	27	Impounding reservoir, muddy, polluted water, supply adequate.
5.	1,840	34	Impounding reservoir, water coagulated with alum, not filtered, supply adequate.
6.	2,111	47	Wells, quality of water fair, supply scanty.
7.	5,175	50	Impounding reservoir, water filtered, abundant supply, system in service only a few years, consumption will continue to increase.
8.	8,034	75	Impounding reservoir, filtered water, excellent quality, abundant supply.
9.	5,255	76	Well water, good quality, adequate supply.
10.	4,511	77	River water, filtered excellent quality, abundant supply.

TABLE II—FINANCIAL STATEMENT OF TYPICAL WATER WORKS IMPROVEMENT

Items	Present Plant	Improved Plant
Total Investment	$50,000	$110,000
Interest on $40,000 @ 5	$ 2,000	$ 2,000
Annuity to retire the above	750	750
Interest on $60,000 @ 5		3,000
Annuity to retire the above		1,450
Help at office and plant, light, heat, rent, chemicals, repairs, etc.	1,300	2,800
Total yearly expenses	$ 1,050	$ 10,000
Received from hydrant rental	500	500
Amount that must be raised from sale of water	$ 3,550	$ 9,500
Total water pumped per year, millions of gallons	14.60	38.00
Water not accounted for, 20	2.92	7.60
Net amount of revenue producing water	11.68	30.40
Cost of water per 1,000 gallons	30.4c	31.3c
Actual average water rate per 1,000 gallons	15.4c	35.0c
Actual revenue from water sold	$ 1,800	$ 10,640
Actual loss, to be raised by levy	$ 1,750	
Actual profit		$ 1,140

happen to be the only cities with adequate supplies of wholesome water. Certainly a per capita consumption of 60 gals. per day can be counted on for an adequate supply of good water, after the first few years of service.

Taking this rate of 60 gals. per capita per day, as a basis, we have made an estimate of the financial benefit to city No. 1, which will result after adding an impounding reservoir and purification works, so as to make their supply both abundant and of good quality. With their present system the supply is not only limited but the water is so muddy at times that it can not even be used for laundry purposes and the mud clogs meters so badly that the meter system has been given up and a flat rate substituted. This flat rate brings in a yearly return of only $1,800 (about 15.4c per 1,000 gals.) Even with this low rate many patrons object to their bills, due to the poor quality of water, while on the other hand cities with the higher rates of consumption have rates of 35c to 40c per 1,000 gals., for domestic users, and principal source of revenue.

The financial statement in Table II is based on the following:

Present yearly revenue from water, $1,800.

Actual investment in present system, $50,000, (actual present value about $100,000).

Bonds outstanding, $40,000, which we assume will be retired at the expiration of 15 years, by the proceeds from an annuity or sinking fund, drawing 4 per cent compound interest. The bonds to draw 5 per cent interest until paid.

Cost of additional impounding reservoir and purification works, suitable for the next 30 years, $60,000.

These bonds to be retired at the expiration of 30 years from the proceeds of an annuity or sinking fund drawing 4 per cent compound interest. The bonds to draw 5 per cent interest until retired.

Rate of consumption at present, 23 gals. Average future rate of consumption, 60 gals.

It is here seen that this water works system which is now an expense account to the city, can by the expenditure of $60,000, be converted into a money-making proposition, after the first few years of operation, and at the same time supply a water which the city officials can offer to the public with just pride.

PENNSYLVANIA AND NEW JERSEY ADOPT UNIFORM POLICY REGULATING DISCHARGE OF SEWAGE INTO THE DELAWARE RIVER

(Editor's Note:—The Delaware River forms the boundary between the states of Pennsylvania and New Jersey. During the past few months inspections of the Delaware River have been made and conferences held between the engineers of the Pennsylvania and New Jersey Departments of Health. As a result of these studies a uniform policy as to the degree of treatment of sewage discharged into the Delaware River was formulated and has been approved by the Commissioners of Health of the two states. The statement of the adopted policy, for a copy of which we are indebted to Mr. W. L. Stevenson, Assistant Chief Engineer of the Pennsylvania Department of Health, is presented herewith.)

1. Sewage discharged into the Delaware River from the northern limits of the State of Pennsylvania and New Jersey to a line above the City of Easton and the Town of Phillipsburg shall be treated to

such an extent as to produce a clarified and oxidized effluent; and also, that so far as legally possible, the State Department of Health will prevent the discharge of untreated industrial wastes into this portion of the river.

2. Sewage discharged into the Delaware River from a line above the City of Easton and the Town of Phillipsburg to a line above the borough of Morrisville and the City of Trenton shall be treated to such an extent as to effect the removal of settleable matter by means of efficient sedimentation; provided, however, that in cases where such settled sewage may be discharged into this portion of the river that it may prejudicially affect a water supply, the effluent shall be further treated adequately to safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where the sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health; and also, that so far as legally possible, the State Department of Health will restrict the discharge of untreated industrial wastes which might be a menace to public health or create a nuisance to either sight or smell.

3. Sewage discharged into the tidal portion of the Delaware river, from and including Morrisville and Trenton and to and including Philadelphia and Camden, shall be treated by means of sedimentation and the effluent discharged through submerged outlets into deep water in the Delaware river; provided, however, that in cases where such settled sewage is or would be discharged into the said tidal portion of the Delaware river at such a distance above or below a water work's intake that it may prejudicially affect such water supply, the effluent shall be further treated adequately to safeguard the purified water supply obtained from the river; and further provided, that when plans for sewage treatment works are approved, where sedimentation of sewage is the only treatment required under this policy, the approval shall be subject to the condition that means for the further purification of the tank effluent shall be installed when deemed necessary by the State Department of Health.

3-A. From data now available it is considered that the discharge of only settled sewage into the aforesaid tidal portion of the Delaware river within two miles of a water work's intake of an efficient filtration plant may prejudicially affect such water supply.

4. In case the said point of sewage discharge is from one state and the said water work's intake is in the other state, so that the sewage effluent while discharged within the aforesaid two miles would have to cross the river to reach the water intake, then before a decision is reached by the State Department of Health having jurisdiction over the discharge of sewage, the case shall be taken up with the other State Department of Health for a careful determination of the probability of the discharge of only settled sewage prejudicially affecting the water supply.

THE SANITATION OF RURAL SCHOOLS

By Wm. R. Conard, of Conard & Buzby, Consulting Engineers, Box 310, Burlington, N. J.

A recent count on a trip of about 90 miles, which took us past 12 schools, situated in rural or semi-rural communities, indicated that of that number 10 appeared to have no other sanitary conveniences than the old-fashioned well and privy, and this trip was made through a section inhabited by persons of intelligence and a fair degree of education. This condition being allowed to prevail in this day and generation when by the present means of communication practical city conveniences can be easily secured, and when modern sanitary knowledge is being so widely distributed, and when medical science tells us that children of school age are among those most susceptible to all of the intestinal diseases, is indeed a sad commentary upon our Township and Rural Community school authorities, and the Architect who is usually retained to advise with them.

Few indeed are the schools which are so situated that it would be impossible to install a driven well, whether shallow or deep, from which usually a good potable water might be obtained and in connection with which a hot air, gasoline, or kerosene driven engine, and pump, and in many places an electric motor and pump, together with modern plumbing and pressure tank, could not be installed. And also few there are of these same rural or semi-rural schools that are so situated that they could not have the toilets indoors, and connected to a modern

system of sewage disposal, either by discharging into a cess pool, digesting tank and chamber and from there into underground drains known usually as French Drains, or else into the more modern settling tank and small sludge bed with the liquids flowing away either to French drains, or similar means of filtering and disposing of the liquids.

All this may sound rather fearsome to the layman who has not been accustomed to these things, and I can almost hear him saying: "That is all very well, it sounds modern, up-to-date, and would put us on a par with city folks, but, my, how it would cost! Besides, what was good enough for our parents, and ourselves, is good enough for our children." Such opponents of progress never stop to consider that the life of one healthy person is of more value to our country than the cost of many sanitary systems.

Let us figure what it probably would cost, taking for example a school for 100 pupils located out in the country where the haul for materials would be, say, 5 miles, and where the soil conditions make it possible to get good water from a well not over 60 ft. deep in which the water rises to within 20 ft. of the surface. Suppose we allow $100 for the well. We can get a pump, a pressure tank, and the motive power for the pump for $200, and plumbing and sanitary conveniences sufficient for that many pupils for probably another $200.

For the disposal of the sewage for an average condition this should not cost more than the water system, and in most instances the installation could probably be such that there would be practically little or no maintenance costs. Then the school will have a modern, sanitary convenience for the pupils for about $1,000 or $10 per pupil capacity. Let us figure how this improvement can be paid off and consider whether the cost is worth the investment. The cost of maintaining in good repair these conveniences would be little more than the cost for maintenance and repair of the older kind of conveniences, so that the first cost with the interest on the investment would be practically all that it is necessary to figure. Suppose we figure to pay the entire amount off in ten years, as at the end of that length of time there would probably have to be repair and replacements of parts. The first year it would cost the School District $1.60 per pupil yer year and this would decrease year by year until the last payment when the payment would be $1.00 per pupil. This is surely not an extravagant amount to spend on our children, when we consider the benefits to be derived, and when considered from a taxing standpoint it surely ought not to be beyond that which the school district could stand and should be willing to pay for.

PNEUMATIC PUMPING UP TO DATE

By John Oliphant, Chief Engineer Pneumatic Pumping Department, Sullivan Machinery Co., Peoples Gas Bldg., Chicago, Ill.

It is very rare for the pumping engineer to find a complete record or log of a well —while perhaps the wells are the most important thing about a municipal or industrial plant, the contract for the work seems to be let in a haphazard manner and no record required from the driller as to what class of material he penetrated—where it was located, and its thickness, to say nothing of the kind and size of casing and strainers used. It is no uncommon thing to go into a well that has been represented to be of a certain size, to the bottom, and find it has been reduced, sometimes more than once. This entails considerable loss of time and expense to secure equipment that will go into the hole.

A driller should be required to furnish a complete log and this should be as carefully preserved as the deed to the property.

Constructing a Well in a Sand or Sand and Gravel Formation

The standard practice of well drillers is to equip gravel and sand wells with a strainer, designed to shut out the sand from the working barrel of a deep well pump. In time, these strainers become clogged with sand and the flow into the well is thus reduced. By a system of back-blowing, the output from such wells can be permanently increased.

The correct strainer for wells of this class, pumped by the air lift, is a perforated screen with openings of a suitable size to admit the fine material into the well, from which it can be pumped, and to hold back the coarser particles, so as to form a natural gravel filter bed outside of the artificial one.

The force available for getting water into a well is the head, due to the difference between the static level in the water strata outside the well, and the pumping level in the well, minus friction due to the strata and screen. Therefore, the more this friction can be reduced, the greater will be the flow, providing, of course, that an abundance of water is available.

"Back-blowing" can be applied to all wells. The top of the well casing should be sealed; next, by closing the discharge pipe while the air lift is in operation, the air will be forced through the foot piece and will drive the water ahead of it through the strainer and float the finer sand. Then, by opening the discharge, the flow will resume its course toward the surface and bring a portion of the floating sand with it. By a repetition of this operation and by increasing the back pressure if necessary, all of the fine sand immediately outside of the strainer will be collected outside of the screen in such quantities as to shut off the sand and increase the flow into a well, without changing the piping in the well. This process may be repeated at any time, so that the screen and adjacent strata can be kept clear.

When wells are drilled in rock, the action of the drilling tool forces the cuttings back into the crevices in the rock. These may be loosened and pumped out of the well in the same manner.

In the case of wells in fine material and quicksand it is often possible to set a strainer in the sand and drill auxiliary holes alongside the well down to the top of the strainer. Then foreign gravel may be dropped down, which will roll in alongside of the screen and take the place of the sand pumped out—often increasing the yield four-fold, by affording outside of the gravel bed a larger area through which the water may leave the sand.

Pumping From Wells With Compressed Air

This method of pumping is becoming more generally used and is deservedly popular for several reasons:

First. That more water can be secured from a given well than by any other method—as high as 2,200 gals. per minute being secured from a 12-in. well.

Second. The character of the water is improved (due to aeration) as to purity and solubility. Recently a very prominent firm of consulting engineers for one of our large cities found that the treatment for the removal of iron was so much less expensive where the water had been lifted with air that they recommended its use—in spite of an apparently higher pumping cost.

Third. It is a well-known fact that the expanding air absorbs heat from the water and a reduction in temperature is secured. In some ice plants this method is being installed for re-pumping surface water for condensing purposes.

Fourth. As there are no moving parts in the well, no deterioriation is caused by mud, grit, floating sand or long shut downs.

Fifth. As long as the pumping conditions are maintained a sustained efficiency is secured over a long period of time, practically the life of the pipe—and if the conditions change and the pumping head drops, a very small expense is required to re-adjust the system to these new conditions.

Sixth. The fact that a large system of wells covering an extensive area can be operated from a central plant.

The question of submergence is one of the first things to be considered.. In actual practice it is found that various submergences can be used for the same lift.

"Submergence" is a term used to express the water head about the point at which the water is admitted to lighten the ascending column—and may be in the well or in the strata adjacent to the wells. It is expressed in per cent, 100 per cent being the vertical distance from the point at which the air enters the water until it leaves it. While there is no definite division line—the following proportions of submergence will be found effective.

Lifts	Submergence
up to 50 ft.	70% to 65%
50 to 100 ft.	65% to 55%
200 to 300 ft.	55% to 50%
300 to 400 ft.	43% to 40%
400 to 500 ft.	40% to 35%

In proportioning a properly balanced air lift installation there are two principal factors to be considered—slippage and friction. As one is reduced the other is increased and the proper balancing of these two elements of loss makes the most effective installation.

The slippage of a bubble of air through water is in proportion to its size—the larger bubbles slipping faster than the smaller ones. It will readily be seen, therefore, that breaking the air up into small streams and the forming of an emulsion at a point nearest to where the air enters the water is a distinct advantage.

The question of friction is also of paramount importance in determining the areas of the discharge pipe. As there are two elements to be handled, air and water, it is necessary to consider their combined volume. The amount of air depends upon the lift and submergence, therefore the volume handled in the dis-

'charge pipe—not only changes with the lift, but also changes with the submergence for the same lift. The proper size of piping for handling a certain amount of water under various lifts and submergences is one that should be taken up with a practical engineer having experience along this line of work, as there are so many variants that a cut and dried set of rules is likely to be misleading. Another point in regard to a properly installed air lift, that is rarely given the important consideration that it should have, is the smoothness of the discharge piping.

Ordinary commercial piping does not butt joints in the couplings but leaves a considerable space between the two ends of the pipe, the water and air traveling at a high velocity-especially towards the upper part of the lift, and where the bubbles have expanded to a larger size, strikes the edge of the upper pipe in each coupling, thus causing a swirl and a considerable loss in slippage, amounting at times to 10 per cent.

And where a central air line is used the trouble is augmented by the couplings of the air line.

Inserted joint casing or butt joint and pipe should be used for the discharge line and also for the air line, where the central system is used.

As the bubbles of air travel with the water to the point of discharge they increase in size, as the head over them is reduced, and consequently occupy more space in the ascending column and it is often an advantage to take care of this increased column with an increased area of discharge pipe. This increase in volume is not uniform but is much more rapid towards the top of the discharge and is frequently the cause of the unequal or plugging discharge which is inefficient and unsatisfactory. The upper part of the column moving faster, gets away from the bottom and an interval in the discharge of water occurs. A properly expanded pipe will generally correct this—but the expansion should be toward the top of the discharge line.

Summary

I have tried to emphasize the fact that while the air lift is apparently a simple installation there are many features about it not generally known—and thousands of dollars in coal would be saved annually if careful consideration were given to these facts.

It will certainly pay a municipality or manufacturer having an air lift plant or contemplating installing one—to have the matter studied by some one who has had practical experience along these lines.

The foregoing matter is from a paper by Mr. Oliphant before the 1922 annual convention of the American Water Works Association.

SERVICE AS AN ELEMENT IN RATE MAKING

By Carl Wilde, Director of Service, Public Service Commission of Indiana, State House, Indianapolis, Ind.

The principle fully recognized and applied that the character of service rendered by a utility should be taken into consideration as an important element in determining its rates, is of great assistance to the Service Department in that it aids that Department to induce utilities to adopt proper standards and rules of service.

This principle has been recognized by various commissions for some years. On Dec. 30, 1915, the Wisconsin Commission denied a telephone company the right to increase its rates on a line serving only a few subscribers, giving inadequate service and yielding an inadequate rate, until adequate service be established and a reason able effort be made to secure additional subscribers. The Commission said further that if the telephone company should prove unable to give satisfactory service after a reasonable trial period, the Commission would not then oppose the extension of the line of a competing telephone company into the district in question.

In 1919 the Nebraska Commission, in establishing a new schedule of increased telephone rates for a utility operating in several communities made an exception to the general rate increase in favor of subscribers connected with a certain line, where the evidence showed that the line was in very poor service condition.

The Arizona Corporation Commission has ruled that in considering the adequacy of telephone rates, service is one of the principal features to be borne in mind, the subscribers as a rule being willing to pay properly for service which meets their needs adequately.

My own experience in the Service Department of the Indiana Commission has convinced me that this is true. I have been told time and again by utility patrons that they would not object to paying an adequate rate if the service they received was adequate, but that they objected strenuously to paying adequate rates for inadequate service.

The Michigan Public Utilities Commission has also laid down the principle that the quality of the service rendered by a telephone utility should be a vital factor in the determination of its rates.

The Oregon Public Service Commission in discussing the relation of service to rates said:

"This Commission naturally concedes the relevancy and importance of a financial showing, but certainly not to the exclusion from our consideration of the general service conditions and other circumstances surrounding the case, and in this order we must, in fairness and equity to the company's patrons, emphatically reaffirm that the adequacy of the service bears a direct and important relationship to the reasonableness of the rate."

The Missouri Public Service Commission has enunciated the same doctrine, using in one case the following language:

"The subscribers should not be required to pay for the service more than it is reasonably worth. The extent or quantity as well as quality of service must be considered together in their relation to each other, because it is apparent in the record of this case, that the quality of the service has been affected by the extent or scope of the service."

In a case which directly concerned water rates the Missouri Commission said:

"It is the duty of the company to make whatever additions and alterations are necessary to provide not only for the domestic consumption, but as well for fire service by direct pressure, and when the company is prepared to discharge this duty, and not until then, it may properly claim such rates as may be necessary to provide for a net return on the investment used and useful in the public interest.

"The water company is not rendering such reasonable fire service as the city is entitled to receive; the granting of rates which will produce a fair return on the investment used and useful in the service of the public is predicated upon the furnishing of reasonably satisfactory service, and until the company is prepared to furnish such service, it is not entitled to an increase in rates and charges for water service."

The principle that the character of service rendered by a utility should be taken into consideration as an element in rate-making has been discussed in various cases by the Public Service Commission of Indiana.

In its Cause No. 5107, which arose upon the petition of a water utility for increased rates, the Commission used the following language:

"The Commission is of the opinion that while petitioner is entitled to increases in its water rates, the patrons are entitled to better service. The Commission will authorize certain increases in water rates, with a distinct understanding that service conditions must be improved in the immediate future. If petitioner fails in its duty to its consumers, the Commission will entertain a petition to reconsider its present findings and reserves the right to initiate proceedings to annul the water rates herein authorized."

In its Cause No. 6229 the Commission on the petition of certain consumers reduced rates because of inadequate service. Omitting the name of the city and the utility, the Commission in that Cause said:

"If the gas service at———was adequate, the Commission would have no choice, under the law, but to deny this petition and continue in effect the present rates.

"Section 7 of the Public Service Commission Act provides: 'Every public utility is required to furnish reasonably adequate service and facilities. The charge made by any public utility for any service rendered or to be rendered, either directly or in connection therewith, shall be reasonable and just, and every unjust or unreasonable charge for such service is prohibited and declared unlawful.' A public utility is entitled to earn its proper operating expenses, including taxes and depreciation and a reasonable return on the fair value of its property, if it furnishes reasonably adequate service. The evidence in this case shows, and at the hearing respondents admitted, that the gas service in ——— is inadequate. Petitioners submitted the testimony of a large number of witnesses whose residences were distributed over the city, so that practically every section of the city was represented * * * * * * the Company frankly conceded that its service was not adequate and admitted the correctness of the complaints of the witnesses who did testify. The evidence does indicate beyond a doubt that the gas service at ——— has been inadequate for at least a year and perhaps for several years, and that it is now inadequate."

"The ——— Company has a monopoly of the gas business at ———. It purchased the plant and business and entered the territory knowing the law required adequate service at reasonable rates; it has on its own initiative assumed the burden

and responsibility of operating a gas utility at ——— in accordance with the requirements of the law and it has assumed the burden of furnishing adequate equipment and facilities properly installed. It has assumed the burden of furnishing competent and efficient management. The owners of this utility have no reason or right to expect that they ever will be permitted to earn a reasonable return on the value of their gas property at ———, unless and until they do their duty to the public and furnish the character of service which the consumers have a right to expect and demand."

In its Cause No. 5286, which arose upon the petition of a telephone company for an increase in rates, the Indiana Commission employed the following language:

"The Commission believe that the term 'adequate service' extends beyond mere mechanical service—the ability in case of a telephone utility, quickly and accurately to obtain the number called. It includes also a proper attitude on the part of the utility towards the public. The Commission believes that a utility intrenched behind a bad financial showing can not demand increased rates as a matter of right, regardless of its service to the public and its relations with the public * * * * *. The Commission believes that rates should not be increased until service is made reasonably adequate—directly by increased mechanical efficiency and indirectly by a better attitude toward the public."

From the foregoing excerpts from decisions of the Indiana Commission it will be noted that that Commission fully endorses the view that the character of service rendered by a utility should be taken into consideration as an important element in constructing rates.

Indeed it is difficult to conceive of a proper rate structure which does not take into consideration the character of the service given. I have heard counsel for utilities contend that service is not an element in rate-making, but it strikes me that this contention is capable of being reduced to an absurdity. Let us assume, for example, that there are two cities or towns of precisely the same population, topography, area, climate and abundance of water supply. In city "A" a water company is operating and the value of its plant is $100,000. In city "B" another company is operating and the value of its plant is also $100,000. Operating expenses are practically identical, but in "A" the water service is inadequate, frequent break-downs occurring due to carelessness and inefficiency; domestic and fire pressure varying and not adequate. In "B", on the contrary, the service is excellent and adequate pressure is maintained at all times. Would it not be an absurdity to cause the water consumers in "A" to pay for their inadequate service as high a rate as the water consumers in "B" pay for their splendid service? To make the same rate in both of these cities would be to place a premium on negligence and inefficiency and to penalize the consumers who must pay an adequate rate for inadequate service.

Of course no two cities are identical in size and conditions, but they vary in degree only and what is true in the hypothetical case in true in reality.

The foregoing reasoning is only applicable where a monopoly exists. In cities and towns where there are competitive utilities competition will take care of differences in service and the utility whose service is bad will soon find that all its customers have gone over to its competitor. This is about the only advantage that I can think of that can ever accrue from a competitive utility situation, and that is entirely obviated where rates are properly constructed, taking the nature and adequacy of the service into consideration as an important element.

To permit a utility to lower its standard of service is to permit the utility to increase its rates. When a rate is fixed a certain standard of service exists, and if that standard is subsequently lowered there results automatically an increase in rates because the utility is giving less for the authorized rate than was contemplated at the time that the rate was granted.

It seems too that a sound public policy would dictate recognition of the rule that the character of service should be taken into consideration in fixing rates because there should be a premium on good service, or to state the matter inversely, there should be a penalty for poor service.

Let me in conclusion deviate for a few moments to speak of public relations as an element of service. In one of the decisions of the Indiana Commission quoted in this paper, unsatisfactory public relations were coupled with inadequate service as grounds for refusing an increase in rates. My observation and such little experience as I have had convince me that no service, however adequate from a mechanical or technical standpoint, can be acceptable and satisfactory to the public

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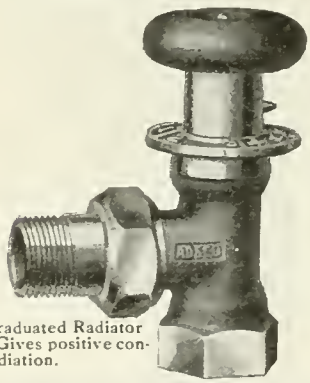

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served unless the relations between the public and the utility are such that there is courtesy and forbearance on the one hand, and confidence and forbearance on the other. Most utilities are corporations and most of them have a monopoly within their territory. The public, because of an indiscriminate damning of corporations and monoplies generally by a certain type of public speaker, and a particular species of periodical, have come to look askance upon any organization to which those two terms can be applied. It is yours to remove this false impression; to show by practical demonstration that a properly regulated monopoly is the ideal situation in the utility field and that a corporation can be as courteous and as conciliatory as an individual. Friendly relations between the public and the utilities are for these reasons as greatly to be desired as the giving of superlative service and if the Public Service Commission in the administration of its duties can aid in the slightest toward bringing about such proper public relations, it's work in that respect will do more toward solving present day utility problems than any other work to which it can set its hands.

The foregoing paper by Mr. Wilde was presented at the 1922 annual convention of the Indiana Sanitary and Water Supply Association.

"BUY MUNICIPALS NOW," SAYS BABSON

(Editor's Note:—Roger W. Babson, the well-known authority on financial affairs, discusses investment opportunities in the public works field in the present article.)

The past few years have been hard for cities and towns desiring to borrow money. During the war a ban was placed upon municipal borrowing and unnecessary public building. Directly after the war money was scarce and rates were high. It has only been within the last few months that cities and towns have been able to secure what money they have desired at a fair rate. Municipal fathers, contractors and investors are now wondering whether the present decline in rates is temporary or will extend over several years.

Study of the situation leads me to believe that the present decline in interest rates will continue and that cities and towns will be able to borrow freely during the next few years. It even looks as if city fathers will soon be solicited by bond houses for issues to sell. Up to the present time city officials have been obliged to hunt up banks to buy their securities. The time will soon come when the bankers will be sending buyers throughout the country to hunt up bond issues that they can sell. We have had years of advancing interest rates and we will have years of declining interest rates.

In addition to the law of business cycles, the tax situation is very much in favor of municipal borrowing. Before the days of income taxes and surtaxes, bonds of our best cities sold on a 3½ per cent basis, and even better. Now, when wealthy men are obliged to pay surtaxes of from 30 per cent to 50 per cent these tax exempt bonds of cities and towns should be in great demand. Some of my associates even state that many of these bonds may go up until they are on a 2½ per cent basis, or less. Of course, this also applies to the Government bonds, although the Government bonds are rather short time and therefore not so attractive to the investor. Cities and towns will temporarily be greatly benefited in their borrowing by any amendment to the Constitution making all bonds taxable. If such a legislation is attempted, there naturally will be a lot of tax exempt bonds put on the market just preceding such legislation. Some feel that such a flood of securities would depress the price, but others believe that if they are to be the last of tax exempt securities, the market will absorb easily all they offer. Whichever is the case, cities and towns will have no difficulty in disposing of their securities during the next few years, and the interest rates should steadily and continually decline.

This means that municipalities should immediately adopt civic planning schemes and probably should make during the next five years such improvements as they ordinarily would in ten. The time to make hay is while the sun shines, and the time to borrow money on long term loans is when money rates are low. Hence, cities and towns should not only borrow during the next few years for their current needs, but should borrow large sums and invest the same for use for years to come, especially during the next period of unemployment.

If cities operated on a business basis, they would borrow their money at times like the present, stow it away, and then spend it when the next period of unemployment comes. By spending it at such times, they not only could get the work

done very much cheaper, but they could perform a distinct service to the people of the community. The general custom followed is the reverse. Cities now do their construction work when it is easy to get money, which is when labor is fully employed and when everyone else is building. This is all wrong. When the period of unemployment comes it is very difficult to borrow money for construction work because money is then tight and the citizens feel poor. Hence, under the present system it is impossible to do much to relieve unemployment when it comes. If an ice man attempted to follow the same system in his business as the city officials follow, he would wait until summer to cut his ice!

For investors this means that tax exempt securities and town bonds should now be purchased even though they have already gone up some in price. When buying tax exempt issues seek the long term ones as these will show the greatest profit. A great deal of public work will be done during the next few years. City water plants will be extended, more sewers will be constructed, new public buildings will be erected and the good road movement will continue to grow.

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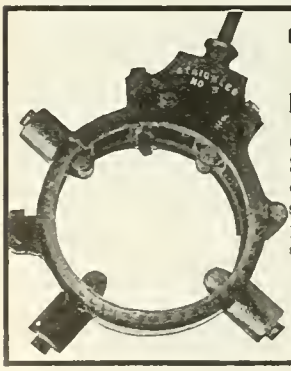

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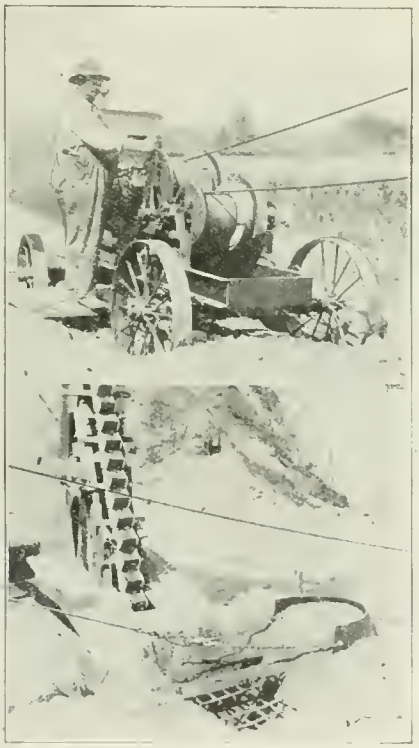
PORTABLE POWER DRAG SCRAPER OUTFITS

To meet the requirements of the man who is handling material in a small way, especially the county road commissioner or contractor who wishes to utilize a local sand and gravel deposit, a new type of portable power drag scraper outfit has been placed on the market by Sauerman Bros., 1142 Monadnock Bldg., Chicago.



SAUERMAN PORTABLE DRAG SCRAPER OUTFIT.
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The new outfits are equipped with "Crescent" type power scrapers, which are especially suited for use with a light power unit as they are easy to pull and travel straight. The doube drum hoist is furnished with gasoline engine direct connected, or is arranged for belt drive from tractor or other motive power. The truck frame is of heavy steel channel construction mounted on broad tread, grooved steel wheels with steel axles.

Any laborer on the job can operate a Sauerman portable scraper outfit. One man handles the entire operation through two levers placed side by side. There is nothing for another man to do, for the scraper just has to be dragged back and forth, loading and dumping being accomplished automatically at the will of the operator. The front drum of the hoist operates the "load" cable which leads through a sheave from the drum to the bridle chains on the front of the scraper. The "pull-back" cable leads from the rear drum through another sheave out to a guide block at the far end of the excavation, and then is attached to the rear bridle chains of the scraper.

The entire outfit can be made ready to move in a jiffy and in less than an hour after arriving at new location it can be in operation. In moving from one set-up to another, simply wind the cables on the drums, disconnect the bridle cable, put the scraper and blocks on the truck, hook on the tractor, motor truck or team, and pull out. At new location sink the wheels of the power unit into the ground, connect bridle cable to new stakes or deadmen, locate guide blocks, haul out the cables, hook onto scraper bucket, turn over the engine and go.

These little outfits are modest in price, yet embody the same quality features of design and construction that are found in the large Sauerman power scraper and dragline cableway excavator equipment.

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A very practical accessory in the form of a rotary pump which can be readily attached to the standard 5-ton "Caterpillar" tractor is now being offered to the trade by the Holt Manufacturing Co., Peoria, Ill. The pump is of special design, compact in size, and is attached to the

rear of the tractor in exactly the same position as the power pulley attachment. It is driven direct through the countershaft from the motor and is capable of delivering 220 gals. of water per minute under working pressure of 100 lbs. per sq. in. At normal speed of 1,000 R.P.M. it throws a 1⅛-in. stream 100 ft. in the air and requires but 26 h.p., which is only approximately two-thirds of the normal motor capacity of the 5-ton "Caterpillar." There is accordingly a large reserve for overloading, should the pump be called upon for extra heavy duty.

This reserve capacity enables the use of a long hose both for intake and discharge. Where an ordinary length of hose is employed a very broad area can be quickly drenched with a very heavy stream. One special field of usefulness is in patrol work in state forests, in the timber districts, etc. The "Caterpillar," of course, has the power and the capacity

VIEWS OF ROTARY ATTACHMENT FOR 5-TON "CATERPILLAR" TRACTOR.

to travel over all sorts of ground, is able to penetrate to points inaccessible to other machines or vehicles, and is able to travel at an active speed. Where a stream or other water supply is available the "Caterpillar" with pump attachment can render vitally important service in forestry work.

Another interesting use for this pump is in municipal fire service. Many cities and towns employ "Carterpillar" Tractors for road building and maintenance in the summer and for snow removal in the winter. By means of the pump attachment the "Caterpillar" is always ready for emergency use in case of fire. A hose reel cart can be quickly transported from the central station to the fire, the intake hose placed in any convenient well, cistern, tank or stream, and a flow of water is instantly available equal to that of any of the usual type fire engines. For pumping out cellars in flooded conditions, as an auxiliary for irrigation work, for use by contractors in pumping out excavations, trenches or cofferdams, this pump is convenient and practical not only for its capacity, but because it can be quickly placed at any desired point.

In general design this pump is of the rotary gear wheel type, with all working parts mounted in a heavy cast iron case which preserves perfect alignment. The two main shafts are geared together at the outer ends and carried in Hess-Bright anti-friction ball bearings. The gears are of special alloy steel, machine cut, ground and heat treated. The stuffing boxes are quickly accessible and easily repacked. A positive jaw clutch connects and disconnects the power to the pump in the same manner as the power pulley would be controlled. The efficiency of the pump is increased by the fact the pump gears are driven through the closely fitted spur gears at the extreme rear. These latter gears are enclosed in a tight case and run in a bath of oil. The entire driving load of the pump is taken by the spur gears so that in this way none of the metal to metal contact comes on the pump blades. In addition to the ample lubrication for the drive gears, compression cups are provided for the main ball bearings. While this pump is built extra strong for heavy duty service it is light in weight, weighing only 225 lbs.

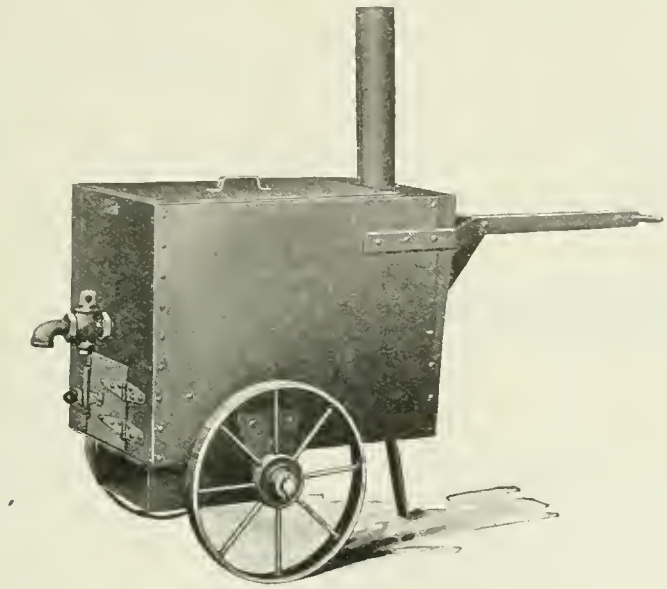
This new rotary pump has been developed through the co-operation of Holt enginners and the Goulds Manufacturing Company, Seneca Falls, New York, and has been tested and proved dependable under many different field conditions.

As this pump can be readily attached to any new 5-ton "Caterpillar" tractor or any of the 5-ton tractors already in the field, the Holt Manufacturing Company anticipates and active demand for this pump, as its field of usefulness is practically unlimited.

TAR AND ASPHALT MAINTENANCE HEATER

The Littleford Midget No. 69, here illustrated is made similar to the regular heater of this type, except that it is smaller and built of lighter material. It is more adaptable to road maintenance work, as it is more convenient to move about and can be handled by one man.

State Highway Departments, County Road Commissioners, and Municipalities are using this particular heater for patrol work with great success.



NEW TYPE (LITTLEFORD MIDGET NO. 69) TAR AND ASPHALT HEATER.

The capacity of the kettle of the No. 69 Midget is 25 gals., which is sufficient for the average patrol work. A convenient drain is provided at the rear where the valve is kept warm because of its close proximity to the fire box.

The construction of this heater is exceptionally durable. The large fire box is fitted with renewable cast iron grates and the furnace shell is protected by liners of fire box steel. The rectangular kettle is removable. Seams are heavily welded, thus eliminating all possibilities of leaks and possible danger of fire. Removable cover is provided.

The No. 69 Midget is mounted on two all steel wheels of 18-in. diameter with 2x⅜-in flat tires. The axle is 1¼-in. diameter. A rugged handle, well braced and fitted with stiff leg is attached to front end at a convenient height for drawing the heater about.

NEW TROWELLER FINISHER ON AUSTIN CONCRETE TAMPER

The perfect finish of a well plastered wall is what the new Troweller Finisher on the Austin Concrete Tamper mechanically duplicates. Hand trowelling has always been unsatisfactory and expensive, due to the width of the road. The Austin Troweller, however, overcomes all difficulties incident to the old method, takes advantage of every good point and, in addition, follows the crown perfectly.

The carriage, accurately made and fitting the adjustable profile bar, a templet of the exact crown of road required, travels across the road with a razor-stropping motion, at speed greater than that of hand trowelling. Two steel adjustable plows, one on each side of the 24-in. trowel proper, press down and work the surplus material. Easily controlled by two levers, a vertical lift is provided for the profile bar, and the stroke is made adjustable, so that it is possible either to trowel the full width of the road or work at any particular spot. At the back of the carriage is a mechanism which slightly tilts the trowel up in the direction of travel.

The net result of the Troweller is to provide in the final finish a perfectly contoured road, swept by a trowel guided with mechanical accuracy for its entire srtoke by a profile bar. No more dependence upon the human eye or effort

to maintain a faultless grade. Furthermore, it provides a means for resurfacing any spots that may from any cause be disturbed by lack of sufficient concrete, footprints or foreign material.

A NEW PIPE WRENCH

The "Little Giant" pipe wrench, a new wrench with several interesting improvements, has just been put on the market. The wrench has the "end opening" feature which is familiar to users of machinists' wrenches. Its application to pipe turning can readily be seen by a glance at the accompanying cut.

The advantage of this wrench over the conventional style is the ease with which it can handle pipes in corners, close to walls, and similar confined places. The person using it can set it straight on the pipe as he would a pair of pliers, instead

THE "LITTLE GIANT" PIPE WRENCH.

of having to fit the jaws on from the side.

The wrench has only three parts—a handle and jaw in one piece, which is drop forged and heat treated; a movable jaw, likewise drop forged and heat treated, and a hardened steel nut. There are no springs, rivets, frame or pins, all these parts being eliminated. In spite of the absence of springs the wrench takes hold and releases instantly at the option of the user.

The new wrench has been designed for maximum strength. The 14-in. size has repeatedly withstood stresses in excess of 4,700 inch pounds without slipping or bending. Readers familiar with government requirements will recall that the army and navy departments require a test of 2,800 inch pounds for a wrench of this size. Yet owing to the elimination of extra parts the "Little Giant," in spite of its extra strength, weighs less than a Stillson type wrench of corresponding capacity.

Another feature is the double set of teeth on the main jaw. The movable jaw can be engaged at the option of the operator with either of these sets of teeth with consequent lengthened life. On the large sizes, 14 in. and greater, two additional sets of teeth are provided, making four in all, and the movable jaw can be reversed to engage these additional sets of teeth, which are below the adjusting nut. This is very useful in connection with certain classes of work, besides practically quadrupling the life of the tool. The wrench is being manufactured in 8, 10, 14, 18 and 24-in. sizes, of which the three smaller sizes are already on the market. The new wrench is a product of the Greenfield Tap and Die Corporation, Greenfield, Mass.

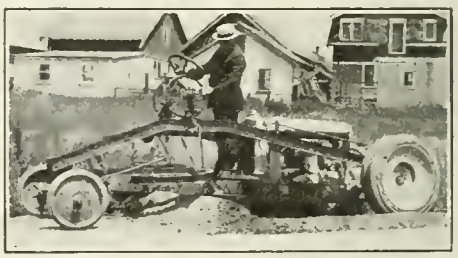
A ONE-MAN ROAD GRADER

The Wehr one-man power grader is designed to meet the requirements for city street and county road maintenance work, also finishing work and light grading for the contractor.

The machine is heavily constructed, utilizing the Fordson tractor as its power unit, which enables the user to get quick service on any motor parts in any part of the country.

The grader is constructed of heavy steel channel frame and is put out with either a 6-ft. or 8-ft. blade. The 6-ft. blade is for finishing work and grading and the 8-ft. blade for maintenance work. The blade can be raised or lowered and tilted at any angle desired by the operator.

The tractor is simply controlled by the operator and can be handled as quickly and as readily, as by the operator on the tractor seat.



VIEW OF WEHR ONE-MAN ROAD GRADER DRIVEN BY FORDSON TRACTOR.

The motor is swung on a three-point suspension so that no unnecessary strains are put on the power unit. This construction enables the full application of the power unit direct to the cutting blade, utilizing the weight of the power unit to hold the grader steady on the road when working. For this reason this machine will do considerable more than any

other light type machine on the market, where the power is utillzed ahead of the cutting blade.

Scarifier arrangements will be furnished as regular equipment and screws which operate the raising and lowering of the blade, will operate the scarifier also.

The standard Fordson tractor wheels can be utilized, but any rubber tire wheel equipment can be utilized for highway or city street maintenance work. The wheels shown in the photograph welgh 1,400 lbs., and are rubber cushion, and will secure all the traction that the motor can handle.

For sub-grading or maintaining city streets or county highways, this machine has some special advantages, as it is the only machine for this type of work which enables the operator to screw the blade down, also weight enough to hold the blade in hard roads.

This combination makes a very low priced economical maintainer which will do three times the work of any horse-drawn equipment.

ST. PAUL ADOPTS ZONING ORDINANCE

By George H. Herrold, City Planning Engineer, City Hall, St. Paul, Minn.

The City Council of St. Paul, Minn., passed a zoning ordinance, Friday, July 7th. The ordinance was prepared by the City Planning Board, George H. Herrold, City Planning Engineer, and Ed. H. Bennett and Wm. E. Parsons, Chicago, Ill., Consultants.

The ordinance provides for six Use Districts and four Height Districts, areas are made to conform to the uses all shown on one zoning map. The residential areas are divided into A, B and C residence districts. There is also provided a Commercial District, a Light Industry District and a Heavy Industry District.

The material difference between A and B residence districts is that the area required per family is greater in the A district. Apartment houses are not permitted in either A or B residence districts, but are permitted in the C district. There are special provisions in the ordinance relating to: 1, the grouping of institutional buildings in order to preserve the residential character in the A and B residence districts; 2, the construction of public garages which are not permitted in the A, B and C districts; 3, the establishment of set back lines in the residential districts, and 4, the requiring the stores to take the same set back as the residence where they are permitted at certain corners in the residential areas.

There are four height districts: 40, 75, 100 and 150 ft. The original ordinance called for a height limit of 120 ft. in the downtown business district but this was amended to 150 ft. by the Council. There are provisions in each for increasing the height above given by setting back 1 ft. in height for each ft. the building is set back in the 40-ft. district; 2½ ft. in height for each ft. building is set back in the 75-ft. district; 3 1-3-ft. in height for each ft. building is set back in the 100-ft. district and 4-ft. in height for each ft. building is set back in the 150-ft. district.

The zoning ordinance was authorized by the State Legislature, Chapter 217 Session Laws of 1921. It provides for zoning under the police power. A Board of Zoning is established, consisting of five members of the Planning Board and the City Architect. Provisions are made for amending the ordinance upon petition of 50 per cent of the owners of the frontage after review by the Board of Zoning and a two-thirds vote on the part of the Council.

The ordinance was first presented to the Council on April 26th. On the date of the third reading, May 23rd, at which time the ordinance must be approved as to form or postponed, the St. Paul Real Estate Board appeared before the Council and asked for six months' time to review the ordinance—this was refused; they then asked for 30 days which was granted. The report of the St. Paul Real Estate Board submitted to the Council June 30th recommended that all car lines be zoned for business, other changes asked for were minor, representing small changes in boundary lines, increasing the area in which apartments might be built and business go in.

There was considerable argument over the question of throwing residential areas along car lines into a business district, but this was finally accepted, incorporated in the ordinance and passed as to form on the date named June 30th, and finally passed July 7, 1922.

The field work on the St. Paul zoning ordinance began in May, 1921. A complete field survey was made to determine the use of every piece of property in the city, and these uses were noted by symbols on a new map of the city prepared by the City Planning Board on the scale of 500 ft. to the inch. Set-backs, height

of buildings, etc., were also determined by the survey. Upon this was built up the zoning map.

It is of interest to note that no public hearings were held on this ordinance, although considerable publicity work was done by presenting the general principles of zoning to all clubs and civic organizations and through the newspapers, and in some cases exhibiting the tentative zone plan. All newspapers of the city backed the zoning ordinance and the City Planning Board to the limit.

The ordinance required four readings before the Council, and on these dates which were published, objectors appeared, but these were not many. It was the viewpoint of the City Planning Board and of the Council that public hearings would develop individual opposition only, and that as a zoning ordinance was for the good of the greater number and being done under the police power that individual objectors should not influence the plan.

Ample provision, however, was made in the ordinance to permit those who felt aggrieved to present evidence and petitions to have the ordinance amended after its passage.

St. Paul has a population of 240,000 and an area of 55.4 sq. miles. We have no congested areas and no tenement districts. The most congested area, one-quarter square mile in the old residential district to the west of the State Capitol Building is 40,000 per sq. mile. The existing area for each purpose and as zoned is shown in the following table.

	Present area in sq. mi.	As zoned area in sq. mi.
Residential	17.20	31.05
Business	.9	1.78
Industrial & R. R. Land	3.8	12.10
Miscellaneous, Parks, Cemeteries, Rivers, Lakes, etc.	6.52	6.62
		Unassigned
Vacant	27.08	3.85
	55.4	55.4

U. S. ROADS BUREAU COMPILES HIGHWAY COSTS

Average costs per square yard of various types of paving for country roads have been compiled by the Bureau of Public Roads, United States Department of Agriculture. The figures cover 68,000,000 sq. yds. of paving constructed with Federal aid in all parts of the United States during the period 1916-1921. The costs per square yard are as follows: Sand-clay, 18 cts.; gravel, 46 cts.; plain and surface-treated macadam, 95 cts.; bituminous macadam, $2.10; bituminous concrete, $2.50; plain cement concrete, $2.57; reinforced-cement concrete, $2.74, and brick, $4.10. These figures cover only the cost of the paving; they do not include the cost of grading.

A total of 28,135 miles of road have been built with government aid since July 1, 1916, when the congressional act under which the Federal government was authorized to aid the states in road building went into effect. The total estimated cost of these roads has been $496,151,683.43. Of this amount Federal aid comprised $211,135,376.31.

The average cost per mile of road construction during the five-year period runs from $8,115 per mile for graded and drained roads, to $39,540 per mile for concrete, and $49,570 for brick roads. The average cost of all roads, including graded and drained, sand clay, gravel, macadam (waterbound), macadam (bituminous), bituminous concrete, concrete and brick roads, was $17,630. Federal aid was at the average rate of $7,500 per mile.

SOUTHERN STATES HAVE BIG ROAD PROGRAMS

In road building and street paving work the southern states are showing greater activity than at any time in their history. Contracts reported during the past four months aggregate in value about $40,000,000. Every state in the South is showing tremendous progress, especially in road improvement. Contracts awarded in the last four months include, in value, the following: Alabama, $1,870,000; Arkansas, $842,000; Florida, $4,800,000; Georgia, $780,000; Kentucky, $870,000; Louisiana, $932,000; Maryland, $966,000; Mississippi, $844,000; Missouri, $2,735,000; North Carolina, $7,780,000; Oklahoma, $1,975,000; South Carolina, $1,104,000; Tennessee, $833,000; Texas, $6,657,000; Virginia, $690,000; West Virginia, $4,523,000. In addition to the actual contracts awarded, there is a tremendous volume of highway improvements for which plans are being made and for which bids will be received during the year.

Contracts Awarded

ROADS AND STREETS

Ariz., Phoenix—Pacific Constr. Co., Phoenix, awarded contr. for paving East Sect. Mesa Hwy., 5 miles in length. Contractor bid $12,923 in bitulithic pavement on bitum. base course and $13,030 on altern. No. 3 which calls for asph. conc. surf. course on bitum. base course; White & Miller, Phoenix, awarded contract for 5 miles impvt. on Bisbee-Tombstone Hwy., at $51,744 for 52,800 sq. yds. asph. conc. surfacing. Warren Bros., Phoenix, awarded contract for Flagstaff paving at $25,381, including 10% for engrg. and contingencies. Ben Pearce, Phoenix, awarded contract for impvt. of Nogales-Willows Hwy., at $65,536.

Ark., Mena—Western Constr. Co., Little Rock, awarded contr. for 15 miles hard surf. road on Talihint Hwy. bet. Mena and Okla. state line, at $124,520.

Cal., Bakersfield—Kneen & Austin, Dudley Blk., Santa Monica, award. contract for paving D, E, G, K, L, N and P Sts., in Dist. 77, at $174,538. Warrenite-Bitulithic in Dist. 77; 3½-in. asph. conc. base.

Cal. Sacramento—Pacific Constr. Co., San Francisco, award. contract for constr. of 16.53 miles state hwy., Humboldt Co., at $439,211.

Cal., Sacramento—Kaiser Paving Co., Oakland, awarded contr. for constr. of 10.7 miles state hwy. in Siskiyou Co. bet. Upton and Shasta River, at $163,934.

Cal., Sacramento—Geo. H. Oswald, 366 E. 58th St., Los Angeles, awarded contr. for constr. of 8.77 mi. state hwy. in Orange Co., at $126,615.

Cal., Sacramento—Southwest Paving Co., 415 Washington Bldg., Los Angeles, awarded contract for constr. of 10.3 miles state highway in Santa Barbara Co. bet. Cana de Los Llagas and Los Chiqueros Crk. with asph. conc. wearing surface, at $103,705.

Cal., Sacramento—Pacific Constr. Co., Oakland, awarded contr. for constructing 8.5 miles state hwy., Merced Co., at $125,586. Blanco & Taylor, Vallejo, awarded contr. for constructing 12.2 miles state hwy., Merced Co. bet. San. Luis Crk. and Los Banos, at $216,550.

Cal., San Bernardino—H. H. Lienau awarded contr. for paving Hellman Ave. (R. D. 1 No. 17), at $108,000.

STEWART SEWER CLEANING MACHINE

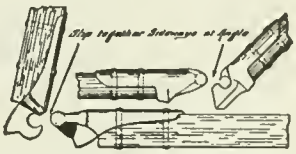
Water Cleaning System, if you wish it, or Drag Bucket type.

Also have TURBINE SEWER CLEANING MACHINE at Low Price.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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Investigate our JUMBO ROD

W. H. STEWART

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CANADA FACTORY, WALKERVILLE, ONT.
Therefore No Duty for Purchaser to Pay.
PACIFIC COAST DELIVERIES MADE FROM SAN FRANCISCO.

Fla., Green Cove Springs—T. B. Gillespie, Palatka, awarded contr. for 60,000 sq. yds. brick paving; $115,000 bonds available.

Fla., Ocala—Florida Asphalt Block Paving Co., Tampa, Fla., awarded contract for 55,000 sq. yds. paving at $100,000.

Fla., Winter Haven—Stidham & Hughes, Lake Wales, Fla., awarded contr. for 127,000 sq. yds. street paving, necessary curb, gutter & draing.; asph. conc. on limestone base, at $300,000.

Ill., Chicago—White Constr. Co., 17 N. LaSalle

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The Non-Skid Ink Stand

(and Paper Weight)

is of particular value to drawing ink users who work on a slanting drawing board.

It will not slide unless the board is inclined to an angle of more than 27½ degrees.

A cork insert at bottom does the trick, and make it "stay put."

PRICE, 35c, POSTPAID

$3.50 Per Dozen.

KOLESCH & CO.

138 Fulton Street New York

K TRADE MARK

St., awarded contr. by Bd. Local Impvts., City Hall, for grading, paving and bldg. sewers in Blaine Pl. N. Francisco, N. California Aves., N. Mozart, Argyle and Ainslee Sts., at $200,000.

Ill., Springfield—Milburn Bros. awarded contr. for laying 5.03 mile stretch of hard rd. thru sect. 16, Winnebago Co., at $104,476.

Ill., Springfield—Cameron-Joyce, Smith-Elder Co. awarded contract for 17 miles hard rd. on Route No. 4, known as Illinois Blvd.—bet. Bloomington & Logan Co. line, at $368,353; also contr. for 3-mi. sect. hard rd. on Corn Belt trail in Woodford Co. and 5-mi. sect. of Corn Belt Trail in Woodford Co. went to Keokuk Quarry Co.

Ind., Mich. City—Municipal Paving & Supply Co., Michigan City, Ind., awarded contract for constr. of 4½ miles of the continuation of the Dunes Hwy. east of here. Road will be of conc., 20 ft. wide. Contr. price abt. $90,000.

Ind., Indianapolis—Hays Constr. Co., Indianapolis, awarded contrs. for approx. 39 miles paving, at $121,068 (5 projs.). The Barrett Co., Chicago, awarded contracts for approx. 30 miles, including constr. of 7.2 mi. of hwy. from Jeffersonville no. on Hamburg Pike, 1 mi. New Albany connectg. rd. Albert W. Karsteter, Lawrenceburg, received 1 contract for 10.1 miles constr., at $32,253.

Ky., Ashland—Sam L. Steele, Ashland, awarded contr. to pave sts. and alleys in So. Ashland and Normal City; brick and bitum. macadam, at $240,000.

Ky., Frankfort—Following contracts let by State Hwy. Comn.: Laurel Co., grade & drain 5½ miles, London-Mt. Vernon Rd., to E. A. Wilson, Knoxville, at $16,974; Caldwell Co., grade & drain 14 mi., Princeton-Marion Rd. to Costello Bros., Knoxville, at $57,211; Harlan Co., grade & drain 5.9 mi. Harlan-Pineville Rd., to Dempster Construction Co., Knoxville, at $93,818; Barren Co., rock asph. on 7 mi. so. of Glasgow to Geo. M. Eady Co., Louisville, at $198,098; Estill Co., waterbound macadam surf. treated on 4.1 mi. Irvine-Richmond Rd., to Conley Constr. Co., Somerset Co., at $69,841; Christian Co., rock asph. on 1 mi. from Hopkinsville to Western St. Hosp. to N. E. Stone, Madisonville, at $37,450. Maint. contracts as follows: Bell Co., surf. treatg. 12 mi. Pineville-Middleboro Rd. and 1 mi. Middlesboro-Cumberland gap rd., to Southern Oil & Tar Co., Louisville, at $9,361 for tar; Nicholas Co., surf. treating with light tar & heavy oil 4 mi. on Carlisle-Owingsville & Lexington-Maysville pikes, to R. B. Tyler Co., Louisville, at $7,228; Shelby-Co. surf. treating with medium oil 5.25 mi. Shelbyville-Eminence pike to R. B. Tyler Co., at $2,859; Cumberland Co., crowning, shaping & graveling 7.52 miles, Burksville-Edmonson Rd., to Alexander & Beck, Harrodsburg, at $16,780; Todd Co. surf. treating with medium oil 4.34 mi. Elkton-Hopkinsville Rd., to R. B. Tyler Co., at $3,215; Jefferson Co. surf. treatg. with tar 14.4 mi. Louisville-Taylorville pike, to Southern Oil & Tar Co., at $10,666; Bourbon Co. surf. treatg. with medium oil 12 mi. Paris-Mt. Sterling pike, R. S. Tyler Co., $6,432.

Ky., Louisville—Henry Bickel Co. and Louisville Asphalt Co. awarded contract at about $200,000 to pave between 2 and 3 miles of streets.

La., Springfield—L. A. Loustalot, Franklin, La., awarded contr. to gravel surface 17.8 miles Hammand-Baton Rouge Hwy., Secs. A & B, Livingston Parish, at $139,813.

Me., Augusta—Contracts awarded by state highway commission: Town of New Gloucester, 4.66 mi. cem. conc. to Jos. McCormick, E. Providence, R. I., at $191,120; Town of Wilton, 0.35 mi. gravel to Jas. H. Kerr, Rumford, at $17,538; Island Falls, 0.32 mi. gravel, Murtagh Hughes, Bangor, at $8,236. Easton, 3.14 to M. Hughes at $47,228; Orono, proj. 43, 2.19 mi. cem. conc. A. D. Bridges & Sons, Inc., Hazardville, Ct., at $57,326; Orono, Proj. 53, 1.76 mi. cem. conc. to Hassam Paving Co., Worcester, Mass., at $50,717; Canton, proj. 32, 5.023 mi. gravel to Jas. H. Kerr, Rumford, at $46,101; Canton, proj. 35, 3.443 mi. gravel to W. H. Doran, Mercer, $32,064.

Mass., Boston—Contr. for paving 19,430 ft. state hwy. Haverhill & Merrimac, conc., to Rowe Constr. Co., Malden, at $189,082; 20,000 ft. in Cummington & Goshen, bitum. macad. to T. J. Quinn, Ashton, R. I., at $221,052; 7815 ft. in Windsor and Cummington to Hanscom Constr. Co., 70 Kilby St., Boston, at $119,803; 3250 ft. in Burlington, gravel and light oil to A. J. Mitchell, Inc., R. F. D. Cohasset, at $4,936.

Mass., Boston—State Hwy. Dept., let contr. for paving 18,950 ft. state hwy. in Windsor & Dalton—bitum. macadam—to Lane Constr. Co., 37 Colony St., Meriden, Ct., at $161,958; 13,700 ft., in Lee, rein. conc., to C. E. Horne, Milford, at $143,139; 5580 ft. in Middleton, bitum. macadam, to J. E. Watkins, 1 Fern Ave., Amesbury, at $29,397.

Mich., Benton Harbor—Northern Constr. Co., awarded contr. for repairing entire length of Ship St.,—Lake Blvd., to Wayne St.—at $224,855.

Mich., Jackson—Brooks Constr. Co. awarded contract for 3 miles sheet asph. from Jackson city limits east to paved rd. thru Washtenaw and Wayne Cos. to Detroit, at approx. $100,000.

Minn., Mankato—Schruth & Welsh, 704 1st Natl.-Soo Line Bldg., Minneapolis, awarded contract for street paving at $132,000. W. Front, W. 4th, Warren, Byron and Liberty Sts.; will be brick on conc. base; Grove St. conc. All alleys conc. of Cl. B rock.

Miss., Heidelberg—United Construction Co., Hattiesburg, Miss., award. contract by Jasper Co. Bd. of Supvrs., for 15 miles Miss. Valley Hwy. thru county, at $120,000.

Mo., Fredericktown—Dick H. Hogan, Little Rock, awarded contr. to construct 16½ miles state hwy. betw. here and Coldwater, Mo., at $210,000.

Neb., Chadron—Roberts Constr. Co., 405 1st Natl. Bk. Bldg., Lincoln, awarded contract for Paving Dist. 3, at $117,378.

Neb., Omaha—National Constr. Co., Federal Reserve Bank Bldg., Omaha, awarded contract for paving 2nd St., and grading, at $85,070.

N. J., Belvidere—Crilly & Cannon Constr. Co., 4 Union Sq., Phillipsburg, awarded contract for constructing State Hwy. Route 9, Sec. 9, from Phillipsburg to Still Valley, at $110,345.

N. J., Morristown—J. S. Geigers Sons, 83 Hartford St., Newark, award. contract for reconstr. of 21,111 sq. yds. Speedwell Ave. from here to Morris Plains, conc., at $144,585.

N. J., Trenton—Rees-Taylor Co., Mechanics Bldg., awarded contr. for constr. of State Hwy. Route 1, Sec. 6, Greenwood Ave., at $95,347.

N. M., Raton—New Mexico Constr. Co., Albuquerque, awarded contr. for paving Dist. No. 9, with 5-in. crush. rock base and 2-in. bitulithic surf., on N. & S. 2nd Sts. Bal. of Dist. is to be paved with 4-in. crush. rock base with 2-in. bitulithic surface. Contr. price approx. $176,000.

N. M., Santa Fe—Following contracts let by State Hwy. Engr.: 13B, FAP, Valencia Co., 16.42 miles, to Peterson-Shirley & Gunther, Omaha, at $84,479; 20A, FAP, Lincoln Co., 2.79 mi. bet. Picacho & Border Hill to McCline & Dobson, Magdalena, at $35,965.

N. Y., Albany—Smith Bros. Constr. Co., Watertown, awarded contr. for Edwards-Fine Hwy., (about 10 miles long) at $353,405.

N. Y., Baldwinsville—Clarence A. Foote & Son, Mt. Morris, awarded contr. for construction of Jordan-Baldwinsville Rd., Part 2; also stretch in village of Baldwinsville, at $279,847. Rd. is 7.16 miles in length and will be of conc.

N. Y., Greenwood—Lee Dennison, Hornell, awarded contr. for impvt. of portion of Canisteo-Greenwood-Whitesville Rd., at $89,873. Wm. L. Collins, Greenwood, has contract for Rushford-Canadea Rd., 1.67 miles in length, at $23,483.

N. Y., St. George—Following contracts let by M. J. Cahill, Pres. Richmond Boro.: repaving roadway of Bradley Ave. to J. E. Donovan, 2205 Richmond Terrace, Pt. Richmond, $68,095; roadway of Bay St.—Thompson St. to tracks of Staten Isl. Rapid Transit R. R. and Richmond Terrace from York St. to Sailors' Snug Harbor Dock, to Brooklyn-Manhattan Contg. Co., 26 Court St., Brooklyn, at $270,378 and $266,573, respectively.

N. Y., Waterloo—The E. W. Foley Contg. Corp., Waterloo, awarded contract for constr. of Ovid-Interlaken Hwy., 6.4 mi. long, at $204,435.

N. C., Raleigh—W. F. McCanless, Charlotte, awarded contract for grading and paving 6.65 miles

Proj. 630-B, Gaston Co., 2-in. bitulithic on 5-in. conc., at $179,241.

N. D., Moorhead—W. E. Kennedy, Fargo, award. contracts for pavings on Front St., 1st Ave. No. and 11th St. So. Moorhead, at $102,784.

Ohio, Columbus—R. B. Sheridan, awarded contract to pave Parsons Ave. from Livingston Ave. to viaduct, at $134,383.

O.,- Columbus—T. D. Van Camp, Columbus, awarded contract for impvt. of Babbitt Rd., at $92,070; 4.16 miles 16-ft. waterbound macadam; E. D. Morris, Columbus, contr. for Walker Rd. approx. 5 miles at $93,447.

O., Findlay—Dorsey Constr. Co. awarded contract by County Commrs. to improve N. Main St. with lake asph. at $125,109.

O., Lima—E. J. Heil, Lima, awarded contract for Lima-Wapakoneta Rd.; brick paving at $135,745.

Ore., Portland—Siems & Carlson, Spokane, awarded contract for grading and surfacing 17 miles forestry road in Whitman-National Forest Reserve bet. Austin and Prairie City, Grant Co., at $266,000.

Pa., Harrisburg—C. E. Walter, Butler, awarded contr. to build 13,917 ft. rd. on hwy. from Franklin to Kittanning at $131,445.

Pa., Harrisburg—Following contracts totaling $1,000,000, let by St. Hwy. Dept.: Cambria Co., Cambria Twp. 9,596 ft. to Lord Constr. Co., Hastings, at $74,818; Lawrence Co. R. 79, 27,081 ft. to Woods & Golder Constr. Co., New Castle, at $207,625; Clearfield Co., Irvona Boro., 7,118 ft. Gifford & Pritchard, Phillipsburg, $54,907; Indiana Co., White, Center & other Twps., 39,082 ft. to Torquato Bros. Co., Windber, at $296,376; Bradford Co. Troy & Columbia Twps., 11,158 ft. The Juaniata Co., Phila., at $89,949 and 25,082 ft. on Route 20, near Gillet, to Henry W. Horst Co., Rock Island, Ill., at $197,759; Jefferson Co. Sykeville & Winslow, 18,716 ft., Mason & Hangar Co., DuBois, at $164,622.

Pa., Pittsburgh—Booth & Flinn, Ltd., Pittsburgh, awarded contracts in Cambria Co. for 21,044 ft. rd. extending from Nanty Glo to Belsano, at $162,042; Jones Constr. Co., Salem, Ohio, award. contr. to build 6,067 ft. Parker City Boro to Armstrong Co., at $65,398; Booth & Flinn, Ltd., also awarded contracts in Indiana Co., at $205,237 for rd. in Greene, Grant and Montgomery Twps.; Torquato Bros. Co. Windber, awarded contr. for 27,632 ft. rd. Indiana Co., at $233,021.

Tenn., Knoxville—Jno. W. Flenniken, awarded contract for asph. paving and conc. curbing of streets in New Iberia, at abt. $150,000.

Tenn., Nashville—Y. Y. Phillips, Martin, Tenn., awarded contr. for 8.54 miles F.A.P. No. 54, at $284,000.

Tex., Breckenridge—Womack Constr. Co. award. contract to grade 21,500 cu. yds.; pave 86,000 sq. yds. with vert. fibre Warrenite bitulithic, Uvalde rock asph., etc., at $822,216.

Tex., Denison—Julian C. Fields & Co., Denison, awarded contr. for 4 mi. State Hwy. No. 19, 37,398 sq. yds. one course conc. pavement, FAP 296, at $93,876; 6 miles St. Hwy. No. 5, 56,320 sq. yds. one course conc. pavement, FAP 295, at $113,616—both in Lamar Co.

Tex., Georgetown—W. E. Dozier Co., Austin, awarded contract for paving about 7 miles Georgetown streets at $200,000.

Tex., Groveton—Smith Bros., Crockett, Tex., awarded contract for 17.4 mi. 16-ft. gravel rd. on St. Hwy. 19, Trinity Co. FAP 225, at $189,932.

Tex., Houston—Hayden & Austin, Houston, awarded contract for surfacing 13.2 miles Hwy. No. 36 near Rosenberg, at abt. $129,000. Specfs. call for base of 6 ins. shell & 4 ins. crushed limestone, topped with 1 in. of Tarvia with limestone filler.

Tex., Taylor—W. E. Dozier, Austin, awarded contract for paving in Georgetown, at $275,000.

Va., Richmond—State Hwy. Comn. let following contracts: 165, Route 9, 3.35 mi. one course conc. state rd. bet. Grove and Lee Hall, to S. R. Curtis & Sons, Lee Hall, Va., at $98,190; 179, Route 9, 7.99 mi. one course conc. state rd. bet. Williamsburg and Acano, to J. U. Addenbrook's Sons, Norfolk, Va., at $230,455.

Wn., Seattle—Albertson, Cornell Bros. & Walsh, Taconia, award. contract for paving with conc. Orillia-Kent Rd. along west side of White River valley, at $138,500. Contr. calls for 20-ft. conc. rd. 4.38 miles in length.

Wn., Seattle—Independent Asphalt Paving Co., Seaboard Bldg., awarded contract for paving Wilson Ave., at $133,467; Jno. Mattson, awarded contr. for paving W. Marginal Way, at $273,217; V. Ramaglia, awarded contr. for paving Hamlin St., at $3,560.

W. Va., Huntington—The J. M. Randich Co., Huntington, awarded contr. for constr. of 4.5 miles hard surf. rd. in Wyoming Co. bet. Mullens and Ellmore, at $194,630. Kingwood-Terra Alta Rd., Preston Co., awarded to Fidelity Constr. Co., also a half mile stretch in Mercer Co.

W. Va., Wheeling—P. J. Gilligan, Cass & Otto and H. L. Seabright, awarded contr. to pave streets with brick on concrete, at $300,000.

SEWERAGE AND SEWAGE TREATMENT

Cal., Long Beach—R. N. Nikcevich, P. O. Box 204, Long Beach, awarded contract for constr. of sewers in Redondo and other streets in Sewer Dist. No. 6, at $98,334.

Cal., Watts—Thompson & Packard, 1113 W. 40th Pl., Los Angeles, awarded contract to construct sewer sys. for City, at $498,000.

Cal., Watts—A. W. Phillips, 587 N. Hoover St., Los Angeles, and M. G. Brkich, 1506 Pleasant Ave., Los Angeles, awarded contracts for sewerawge system here at $442,775.

Ont., Atwood—G. Arbuckle, care G. Lockhead, Atwood, awarded contract for ditching, mostly excav. small amt. tile and conc. work, at $63,742.

D. C., Washington—B. C. Baker, Uniontown, Pa., awarded contr. for constr. of sewers in Brentwood Cottage City and adjacent territory in Prince Georges Co., at $54,573; also contract for sewers in Riverdale at $41,834.

Fla., Lake Worth—Bunker & Lockman, awarded contract to constr. new sewer system, at $89,713.

Ga., Atlanta—McDonald Constr. Co., Atlanta, awarded contr. for extendg. Lloyd St. sewer, at $124,650; extendg. Stewart Ave. trunk sewer to J. B. McCrary Co., 3rd Natl. Bk. Bldg., at $11,907; several small sewers in various streets to Dysard Constr. Co., Austell Bldg., Atlanta, at $27,182.

Ga., Lagrange—J. B. McCrary Co., Atlanta, Ga., awarded contr. for constr. of extension to sewer system at approx. $50,000.

Ky., Louisville—Henry Bickel Co., Louisville, awarded contr. for Bardstown Rd. sewer at about $65,000. J. H. Cahill, Louisville, award. contr. for 44th St. sewer, at approx. $40,000.

Ky., Paducah—E. R. Harding Co., 400 Robinson Bldg., Racine, award. contract for constr. of sewers, 96 and 102 in. rein. conc. monolithic, 42-72 in. clay segm. blk. 15-36 in. vit. clay pipe, at $508,000.

Minn., Brainerd—Riches & Son, Superior, Wis., awarded contr. for sewers, at $38,908.

Minn., St. Charles—Gedney & Murphy, 211 Lbr. Exch., Minneapolis, awarded contract for 35,621 lin. ft. 8 and 10 in., 81 manholes, 15 lampholes, disp. plant, at $64,405.

Neb., Emerson—W. B. Carter, U. B. Bldg., Sioux City, awarded contract for sewer and disposal plant, at $38,383.

N. J., Hackensack—A. Capone, Jersey City, awarded contract for 1st Ward sewer, at $266,879.

N. Y., Brighton—A. Petrossi, Rochester, award. contr. for sewers in Dist. 1, at $33,998.

N. Y., Syracuse—J. Young, Bastable Bldg., awarded contr. for sewage treat. plant, at $68,284.

N. C., Kernersville—Boyd, Higgins & Goforth, Charlotte, awarded contract for water, sewer and discharge system; tanks to R. D. Cob Mfg. Co., Union, Ga.; wells to Cummins & Williams, Kernersville. Total cost abt. $100,000.

O., Columbus—Gessner & Co., 616 Nicholas Bldg., Toledo, award. contract for 23,480 ft. 6-15-in. san. sewers in Dunedin Rd., at $39,018.

Ohio, Hamilton—The W. M. Davis Co., local, awarded contr. for laying san. sewers in Armondale subdiv. at $40,573; Badger Meter Co., Milwaukee, Wis., also awarded contr. for water meters.

Okla., Okla. City—Smith Bros., Dallas, Tex., awarded contr. to construct Lee Ave. sewer at $490,309.

Pa., Philadelphia—Following contracts for sewer construction in various streets let by Direct. of Dept. Pub. Wks.: Fred T. Ruckius, Jr., Allengrove, at $36,000 (portions of 5 streets); Antony A. Pastore, at $36,000 (7 streets); A. J. Ellis, $4,000 (1 st.); D. Delise, $12,700 (3); A. Disandro & Son, $13,000 (3); Emilio Pascuzzi, $18,500 (2); M. Mattia, $8,000 (2); F. Borelli, $1,100 (1) and Nicholas Ferraro, $2,000 (1).

S. D., Sioux Falls—Michael Fanebust, Sioux Falls, awarded contract for sewer construction here at $49,500.

Wn., Seattle—V. Ramaglia, awarded contract for sewers and paving in Woodrow Pl. at $3,115 (clay pipe); Interstate Constr. Co. contr. for sewers in 32nd Ave. S., et al, at $36,775.

Wis., Milwaukee—Paul Riesen's Sons awarded contr. for erecting superstruct. of power house and boiler house for sewage disposal plant on Jones Island at $211,890.

Wis., St. Croix Falls—Hedborg & Heiner, care Toltz, King & Day, Engrs., 1410 Pioneer Bldg., St. Paul, awarded contract for 22,238 lin. ft. san. and 3,096 lin. ft. storm sewers, inlets, sewage treat. plant, manholes, appurts. etc., at $57,000.

WATER SUPPLY AND PURIFICATION.

Ala., Tuskegee—Noland-Clifford Co., Inc., Newport News, Va., award. contract by U. S. Hosp., at approx. $325,000 for constr. and equipt. of boiler plant consisting of 5 boilers, 150,000-gal. steel tank and tower constr. of sewage disp. plant, water system, central heating plant, etc.; also sub-contr. for bldg. 4 deep wells, each 500 ft. and bricking up 5 boilers.

Ariz., Prescott—S. P. Gillis, Engrg. Co., P. O. Box 454, Phoenix, Ariz., awarded contract for constr. of conc. dam in Banning Creek to impound water for City at $79,784. Work involves 800 cu. yds. rock excav. at 33c yd.; 9,600 cu. yds. cyclopean masonry at $8.25 yd. Dam will be a straight gravity type dam, 65 ft. high with vert. upstream face.

Cal., Presidio—(San Francisco, P. O.)—J. W. Roberts, P. O. Bldg., San Francisco, awarded contr. for pumphouse, pump equipt. and fire protection sys., at Marine Hosp. here, from Eng. Structs. Co., Call Bldg., at $21,580; Schultz Constr. Co., 46 Kearney St., $23,500; Burnham Plumbg. Co., 1220 Webster St., $23,900. Above contractors located in San Francisco.

Ont., Islington—Following contracts let for water works system in Area 3, Twp. of Etobicoke; abt. 3 mi. 6-in. cast iron pipe: pipe laying to Grant Contg. Co., 50 Front St., E. Toronto; pipe to Natl. Iron Wks., ft. of Cherry St., Toronto; valves to Drummond McCall Co., 373 Front St., E., Toronto; hydrants to J. T. Hepburn, 18 Van Horne St., Toronto. Engr's. estimate, $60,000.

Que., Montreal—E. G. M. Cape & Co., 10 Cathcart St., awarded contr. for 25,00,000-gal. rein. conc. reservoir, 500 ft. sq., 18 ft. deep, at $575,000.

Ia., Waterloo—C. H. Werner, Waterloo, awarded contract for 2 rein. conc. reservoirs, at $43,000. City will buy cast iron pipe.

D. C., Washington—Philip Agrios, New York City, awarded contract for constr. of water mains for Sec. 3, and Martin's Additions to Chevy Chase and Woodmont, at $73,765.

Fla., Vero—Edw. G. Ladd, Jacksonville, Fla., awarded contract to construct water works system at abt. $51,197.

Me., Auburn—Contract for extending water sys. let to F. A. Rumery Co., 21 Portland St., Portland, at $17,253; 1,200 tons c. i. pipe to Donaldson Iron Co., Emaus, Pa., at $48.70 per ton, specials, $0.055 per lb. Engr's. est. over $50,000.

Md., Cumberland—Cumberland Contg. Co., 62 3rd Natl. Bank Bldg., awarded contract for laying water conduit; engr's. est. $100,000.

Mich., River Rouge—Grfeiling Bros. Co., E. Walnut St., Green Bay, Wis., awarded contract for submerged water main across Rouge River abt. 40 ft. below water surface, 500 ft. 30-in. c. i. pipe, at $46,000.

Minn., Winona—T. Woolley & Son, LaCrosse, Wis., awarded contr. for extension of water main, 14,774 lin .ft. 6-10-in. CI. D cast iron pipe, 10,812 lbs. stand. CI. D c. i. castings, etc., at $31,587.

Miss., Durant—Bobo & Collier, Memphis, awarded contr. for installing sewer system at $16,500; J. M. Evans, Jackson, contr., for laying water pipes and installing hydrants for water sys. at $10,278; Chicago Bridge & Iron Co., Chicago, contr. for erecting tower and tank, at $4,564; U. S. Cast Iron Pipe Co., Birmingham, Ala., contract for cast iron pipe, at $19,000.

Mont., Red Lodge—McLaughlin & O'Neil, Livingston, awarded contr. for 13,020 ft. 6-8 and 10-in. c.i. pipe, 8,900 ft. 8 or 10-in. cast iron pipe, 1 clear well and 2 pressure regulators, at $63,106.

N. J., Trenton—H. E. Stahl, Goodwill Pl., awarded contr. for installing 1 Ames Unaflow engine, 1 rotary pump, elec. generator, condenser, etc. in pumpg plant, at $58,989.

N. C., Asheville—E. T. Belote, Asheville, awarded contr. for repairing city reservoir on Beaucatcher Mtn., at $40,595.

N. C., Goldsboro—B. McKenzie, Greensboro, awarded contract for water pumping equip., power plant piping and apparatus, at State Hosp. for Negroes, at $134,000.

N. C., Hendersonville—Kelly & Wilson, Asheville, awarded contr. for construction of water system, at $181,000.

N. C., Kernersville—Following contracts let: Constr. of 100-ft. tower and tank to R. D. Cole Mfg. Co., Union, Ga.; 2 deep wells to Cummings & Williams, Kernersville; water works and sewage sys. to Boyd, Higgins & Goforth, Charlotte, at total of $100,000.

N. C., Mt. Holly—W. A. Everett, Charlotte, awarded contr. for constr. of water works and sewerage systems, at $75,000.

N. C., Morganton—Boyd, Higgins & Goforth, Charlotte, award. contract for 12 miles 12-in. c. i. bell and spigot water pipe from reservoir to standpipe, at $195,000.

N. Y., Buffalo—Thompson-Starrett Co., 49 Wall St., New York, awarded contract for filtr. plant structures. Contr. No. 1, at $1,800,480.

N. Y., Irondequoit—W. G. Fritz Co., W. Orange, N. J., awarded contr. for 30,000 ft. 6 and 8 in. mains, hydrants, valves, etc., here, at $48,760.

N. Y., St. George—M. DeStefano, 257 Glenn Ave., Tomkinsville, awarded contract for mains in Cary, Carter, Columbus Sts., etc. ,at $15,061; Barton, Bayview, Bedell, Bogardus, Centre, Egan etc., at $49,-892.

O., Columbus—Pitt Constr. Co., Fulton Bldg., Pittsburgh, Pa., awarded contr. for 1,260 ft. 12-in. cement and 1,470 ft. 6-in. mains, at $12,144.

Okla., Bristow—Gibson & Mitchell, Pauls Valley, awarded contr. for extending water works at $46,-018.

Okla., Okla. City—U. S. Cast Iron Pipe Co., Am. Trust Bdg., Birmingham, Ala., awarded contract for 6,000 tons 4-30-in. cast iron pipe, specials, valves, hydrants and valve boxes, at $202,460.

Okla., Wewoka—Yates & Gallamore, Cushing, Okla., awarded contr. for water works impvts., consisting of filtr. plant, intake and repairing dam, at $38,524.

Okla., Wilburton—Ladd Construction Co., Kansas City, Mo., awarded contract for extending water and sewer sys., at $175,000.

S. C., Honea Path—Henry Constr. Co., Greenville, S. C., awarded contr. by Chiquola Mfg. Co., for constr. of water and sewer systems for 132 dwellings; R. D. Cole Mfg. Co., Newman, Ga., awarded contract for steel tank on trestle.

Tenn., Lebanon—Tennessee Mfg. & Constr. Co., Lebanon, award. contract to construct water and sewer systems, at $220,000.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson.
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Texas, Childress—F. P. McElwrath, Corsicana, awarded contr. for dam, spillway, etc. (Item 1) at $144,546; pipe line, pump house, etc. (Item 2) to Hamilton Bros. Constr. Co., Taylor, at $177,124.

Va., Ashland—J. L. MacGhee Constr. Co., Tarboro, N. C., awarded contract for furnishing and laying 4 miles CI. B 8-10 in. iron mains; 25,000-gal. steel tank and tower. to C. D. Cole, Newman; Pittsburgh-Des Moines Steel Co., Curry Bldg., Pittsburgh, award. contract for settling basin, two 80-gal. steel tanks and tower, filtr. plant, 2 triple pumps.

Vt., No. Bennington—J. Long, Leominster, Mass., awarded contr. for water supply and sewerage system, including dam and collecting pond, 2,225,000 gal. distributing reservoir. (Temporary address of contractor, So. Shaftsbury, Vt.) Engr's. est. $200,000.

Wn., Walla Walla—Puget Sound Bridge & Dredging Co., Seattle, award. contract to complete water works impvts., at $132,715.

Prospective Work

ROADS AND STREETS

Cal., Fresno—City Engr. Wm. Stranahan has completed plans and specfs. for impvt. of Faris Ave. bet. Belmont and Olive Aves., involving 107,610 sq. ft. grading, 98,204 sq. ft. asph. paving, 9,030 sq. ft. conc. gutter, 287 lin. ft. 12-in. culvert, 196 lin. ft. 18-in. culvts, 12 manholes.

Colo., Ft. Collins—Sentiment strongly in favor of issuing $6,000,000 bonds for road impvts. in state, to meet similar amt. of fed. aid.

D. C., Washington—More than a dozen streets, in various sections of city, will be paved. Sheet asph. and conc. will be used.

Fla., Pensacola—Fourteen blks. paving in city will be recommended by Street Commr. F. Sanders. Est. cost abt. $50,000.

Fla., Sebring—Highland County plans bldg. main trunk line from Polk Co. to Glades Co. with laterals to Kissimmee River, Cressville and Hardee Co. line. May vote on $500,000 bonds.

Fla., Tallahassee—City Attorney instructed to draw up Ord. for elec. to vote on issue of $125,000 for street paving and $20,000 for sewerage impvts.

Fla., Tampa—Hillsborough Co. will lay abt. 151 miles hard surfaced roadways. $3,000,000 bonds voted.

La., Baton Rouge—E. Baton Rouge Parish Police Jury, Ward No. 4, contemplates laying 8 mi. Samuel Rd.—Baker canal to Parish line; 11 mi. East and West Rd.—Mt. Pleasant to Comite River through Zachary; 7 mi. Bayou Sara Rd. from Ward line; 4 mi. rd. from Zachary to Parish line. Will vote on $125,000 bond issue.

La., New Orleans—State Hwy. Comn. has started surveys and will also prepare bidders' specfs. for proposed temp. rd. at Poydras to connect Terreaud-Boeuf Hwy. with St. Bernard river sect.

La., New Orleans—Commission Council voted favorably on Commr. Black's plan to enlarge 1923 paving program. Revised program provides for paving 51 streets stretching 17 miles. Est. cost $400,000.

Mass., Boston—City will pave 1,200 alleys, having only earth surface. Work will begin in South end and $50,000 has been appropriated for this work. To pave entire 1,200 will cost approx. $2,000,000.

Mich., Detroit—More than $500,000 will be expended this year on improving roads of Essex Co. Work includes widening River Front Rd. bet. Ojibway and Amherstburg.

Mich., Monroe—$100,000 bond issue voted favorably here for paving. All streets will be paved.

Mo., Malden—Prelim. steps taken to pave practically every street in town. Bids will be asked soon. At mass meeting of citizens it was voted to pave residence streets with gravel 24 ft. wide and the 3 business blocks with conc. or asph. J. R. Woffard, Town Clk.

Mo., Jefferson City—State Hwy. Comn. has approved 13 local rd. projects covering total of 55 miles to be built at est. cost of $263,007.

Neb., Omaha—Pub. Impvt. program of $4,500,000 for paving, sewers and sidewalks is mark that City Commr. Jos. Koutsky has set for this season . One dist. of importance embraces Pierce St.—6th to 10th; 6th—Pierce to Hickory and 7th—Pacific to Pierce; the material to be of brick block. Est. cost $55,000. Lake St.—30th to 41st Sts.—will be paved with brick. Curbing will be started this month. This impvt. will cost abt. $59,000. Several street widening and opening projects are on the calendar. 175 paving contracts have been started this season or are ready for signatures.

N. Y., Broklyn—Orders given by Boro. Pres. Connelly (Queens) for impvt. of 10 streets in Queens. Total est. cost $200,000. Most important impvt. is paving with sheet asph. Cooper Ave.—Myrtle Ave. in Ridgewood section, to Brooklyn Boro. line. This impvt. will cost approx. $100,000. Another of the impvts. is paving with sheet asph. Liberty Ave.—104th to 109th Sts.—at est. cost of $50,000. In Astoria section 5th Avenue is to be paved with sheet asph. from Grand to Jamaica Aves.

N. Y., Watertown—Expendt. of county funds amounting to $276,950 and a distribution in 4 towns of $66,120 state aid funds for impvt. of network of hwys. throughout county, authorized in resolutions laid before Bd. of Supvrs. H. S. Ball, Co. Supt.

O., Columbus—Board of Co. Commrs. (Franklin County) have authorized Co. Surv. Lattimer to begin surface treating a number of important roads in County. Roads will be treated with Tarvia and Asphalt. Est. cost abt. $60,000.

O., Findlay—Seven miles paving will be built here this summer.

Ore., Pendleton—Approval of 1st resolution for 15 blocks of paving voted by Council.

Tex., Muleshoe—Bailey Co. Commrs. Court will call for bids abt. Oct., for 19 miles nat. sand clay rd. R. J. Klump, Co. Judge; G. L. Hasie, Engr.-in-Charge, Littlefield, Tex.

Tex., Newton—Will open bids about Oct. 15, for abt. 21 mi. state hwy. No. 7, Newton County, from Sabine River to Jasper Co. line east and west across County. J. E. Rausch, Co. Judge. (Work consists of gravel surfacing).

Tex., Paris—Lamar Co. contemplates gravel surfacing 6.06 mi. St. Hwy. No. 5—Red River Co. line to end of present Fed. Aid Proj.at cost of $41,500; gravel surf. 9.89 mi. State Hwy. No. 19, from point no. of Paris to Red River Co. line; fed. aid granted, $63,500; gravel surfacg. 11.16 mi. State Hwy. No. 5, from Fannin Co. line east toward Paris, $76,300; surface 9.24 mi. St. Hwy. No. 19 from Delta Co. line no.; gravel top; sledge limestone base; $74,122. W. L. Hutchinson, Co. Judge; W. M. Fooshel, Co. Engr.

Tex., Sinton—San Patricio Co. plans impvt. of east branch State Hwy. No. 9, $120,000; St. Hwy. Comn. granted $60,000 Fed. Aid. J. C. Houts, Co. Judge, Sinton; A. C. Pancoast, Co. Engr., Beeville, Tex.

Va., Suffolk—Nansemond Co. plans laying 5 mile conc. rd. bet. Suffolk and Franklin. Let contr. soon.

W. Va., Wheeling—City has decided to pave 1,000 ft. of Warwood Ave.

SEWERAGE AND SEWAGE TREATMENT

Cal., Calipatria—Plans being prepared for constr. of 21,600 lin. ft. 6-12 in. vit. pipe sewers in Assessment Districts 2 and 3. $32,000. H. Tsheppe, Co. Engr.

Cal., Los Angeles—Finance & Health & Sanitation Comm. of Council voted to adopt proposed sewer right-of-way agreement bet. Los Angeles and Culver City, and appropriate at once $465,000 for sewer pipe line and treat. plant to be constructed southeast of Culver City. Contrs. for land, laying pipe and constructing treat. plant will be let immediately. This emergency pipe line will handle

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Truscon Steel Co.

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Elevators.
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Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
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Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

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Kissel Motor Car Co.
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Packard Motor Car Co.
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Duplex Truck Co.
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Kissel Motor Car Co.
Lewis-Hall Iron Works.
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Dee Co., Wm. E.
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Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
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Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
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Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
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Pipe Cutters.
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Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

excess sewage from southwest part of City for next 3 yrs. $12,700,000 sewer bond issue will be presented to voters at Aug. primary and if carried will provide for additional treat. plants and new outfall sewer to the sea.

Ont., Hamilton—City considering sewage disposal system to cost $2,500,000. James, Proctor & Redfern, 36 Tor. St., Toronto, Engrs.

Que., Three Rivers—Plans being prepared for sewer to cost $32,000 on Notre Dame St., for City. C. Gelinas, Engr.

D. C., Washington—Dist. Commrs. 509 Dist. Bldg., plan to lay sewers in various streets, $250,000 appropriated.

Ky., Hazard—Town will install sewerage system, not including sewage disposal plant. Est. cost $50,000. A. G. Taylor, Clk.

Md., Williamsport—Voters have authorized bond issue of $117,930 for extensions to city sewer system.

Mass., So. Boston—(Boston, P. O.)—City plans rein. conc. overflow sewer in Farragut Road extension. $43,300. J. J. Carty, City Hall, Engr.

Minn., Waseca—Plans under way for sewage disposal plant and impvts. Cons. Engr. W. E. Buell & Co., Davidson Bldg., Sioux City, Ia. Jno. Madigan, Clk. Est. $75,000.

Neb., Papillion—Will probably take bids in near future for sewer and water works. Cons. Engr. Rohrborough Engrg. Co., 929 City Natl. Bk. Bldg., Omaha. Geo. F. Oliver, City Clk. $10,000.

N. J., Newark—Est. cost of proposed storm sewer in Hillside, $99,629. Twp. Engr. Wm. H. Luster.

N. M., Artesia—Constr. of sewer system at approx. cost of $500,000 is contemplated.

Ohio, Lima—City Comn. has enacted legislation authorizing 3 storm water relief sewers to cost $800,000 affecting a dozen streets.

Tex., Houston—City will soon receive bids for 10,000 ft. st. sewers in Turner & Castle Ct. Addn. 12-57 in. vit. clay seg. blocks or conc. pipe. $80,000. J. C. McVea, City Engr.

Tex., Lubbock—$100,000 bonds voted here for sewerage extens. and impvts. S. Sanders, City Engr.

Va., Barton Heights—City has tentative plans for impvt. of sewers, streets, fire house, etc. $1,500,000 available.

Va., Petersburg—Plans being made and bids will soon be asked for 3 miles of sewers. $75,000. L. Budd, City Engineer.

Wis., Milwaukee—Plans for diversion of sewage from South shore beach into city sewerage sys., being completed and will be submitted to Sewerage Comn. shortly. Geo. F. Staal, City Engr. A plan for similar diversion at Bradford Ave. beach will soon be completed.

WATER SUPPLY AND PURIFICATION

Ark., Hot Springs—Prelim. ests. completed by Caddo River Power & Irrig. Co., for hydro electric proj. on Ouachita river near here. H. L. Remmel, Little Rock, Pres. 300,000 bbls. cement will be required.

Cal., East San Diego—City Council has ordered City Engr. E. Paul Ford, to prepare plans for water sys. under district plan. Entire system will be of cast iron pipe; mains to be 12, 10, 8 and 6 in. diams., while laterals or feed pipes will be 2 in. cast iron pipe.

Cal., Hermosa Beach—Election will be held the latter part of Aug. to vote on $150,000 bonds for water works and distributing system.

Cal., San Bernardino—Proj. to utilize waters of Lake Arrowhead for domestic and power purposes being promoted by Chambers of Commerce in San Bernardino, Redlands, Colton and Riverside, which have appointed committee to report on the matter. Lake Arrowhead Co. will join in enterprise as Victor Valley side of mountains can be irrigated from Mojave river on which it is proposed to construct dam at west fork, leaving all waters of lake for San Bernardino Valley. Est. cost, including power plants, etc., $2,000,000.

Cal., San Gabriel—$250,000 bonds voted by San Gabriel Co. Water Dist. at recent election. Present district includes portion of city of San Gabriel and adjacent county teritory—total of abt. 21,000 acres, on which there are about 4 wells from which water supply is secured. Part of supply also obtained from Van Nuys Water Company's properties near Raymond dike, Pasadena. Funds voted will be used to build pipe lines and rein. conc. reservoir. J. A. Bell, San Gabriel, Gen. Mgr. and Engr .of Dist.

Ont., Kirkland Lake—Tech Twp. Council plans constr, of water system costing $60,000 at Kirkland Lake and Swastika.

B. C., No. Vancouver—Plans prepared for storage reservoir and water mains to cost $60,000 for North Vancouver.

Conn., Berlin—Plans being prepared for $3\frac{1}{2}$ mi. exten. to water supply sys. in Hudson St., Farmington Ave., Middletown Rd:, and Worthington bridge sections. Oldershaw & Crowley, 259 Main St., New Britain, Engrs.

Ill., Waukegan—Election in near future to vote on $940,859 bonds for filtration plant.

La., New Orleans—Sewer & Water Bd. has approved extensions of 16-in. water main on Canal St. and Canal Blvd.; 12-in. pipe extension from Scott St. to Adams Ave. Approx. cost $65,000.

La., Ponchatoula—City having plans prepared by Swanson-McGraw, Inc., 705 United Fruit Bldg., New Orleans, Cons. Engrs., for water works and sewer system. $125,000 approx. cost.

N. Y., E. Syracuse—Plans new reservoir of one million gal. capy., at est. cost of abt. $100,000. S. L. Adcock, Engr.

N. C., Charlotte—City considering erection of water plant. Wm. Platt, Cons. Engr., Durham. $300,000 available.

Okla., Cushing—City considering extension of water and sewer systems. Est. cost abt. $300,000.

W. Va., Wheeling—Council has approved report of the J. N. Chester Engineehs, in which recommendations were made that comb. filtr. and pumping plant be installed at Warwood; also that plant be steam driven. Council also authorized City Mgr. to secure options on land at head of Jonathan's ravine at First St., for location of the five 1,000,000 gal. reservoir steel tanks. Old plant at Slacktown will not be dismantled until new one is constructed.

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Good Roads Machinery Co., Inc.

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Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
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Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
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Buffalo-Springfield Roller Co.
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Pioneer Asphalt Co.
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Scrapers, Power.
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Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
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Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

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Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

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Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
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Subgrading Machines
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The Hug Co.

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Lufkin Rule Co., The

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Austin-Western Road Machinery Co., The

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The Barrett Co.

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Tarvia.
The Barrett Co.

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Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
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Warrenite.
Warren Bros. Co.

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National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
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The Texas Co.
Truscon Steel Co.

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Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

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The Refinite Co.

Water Works Supplies and Equipment.
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The Flower Company.
Pennsylvania Salt Mfg. Co.

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Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

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Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

Vol. LXIII. SEPTEMBER, 1922 No. 3

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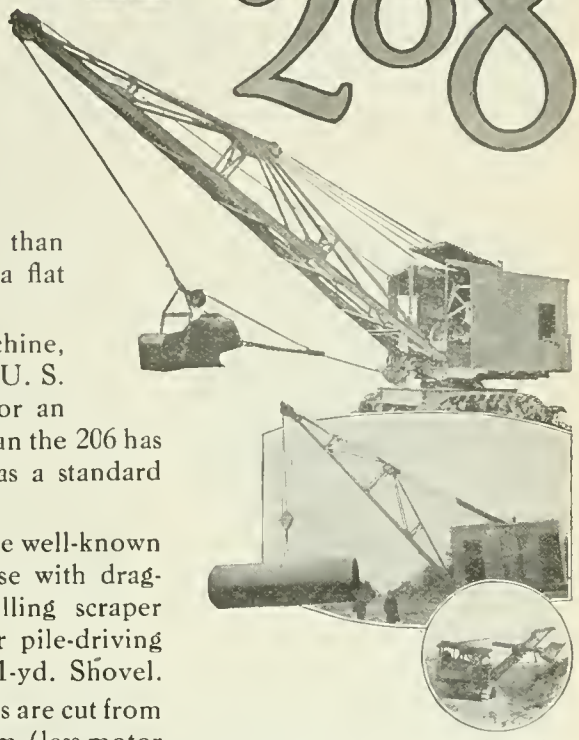

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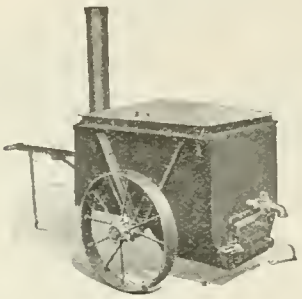

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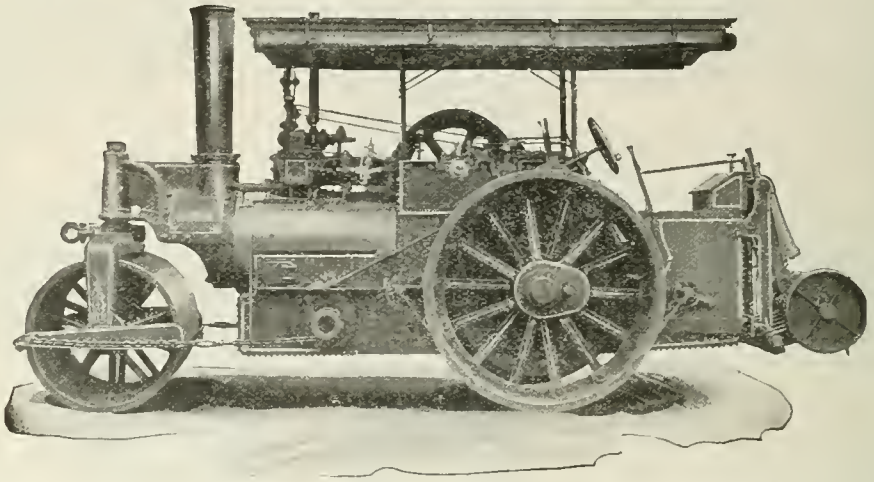

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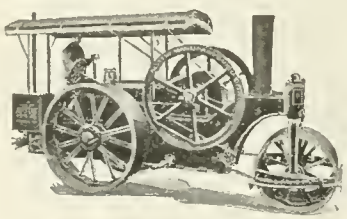

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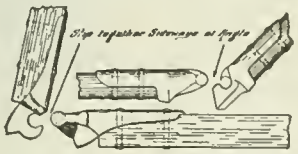

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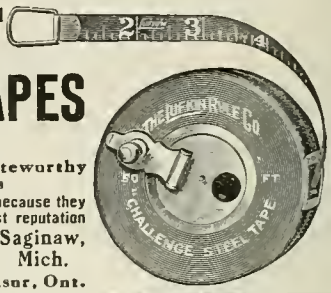

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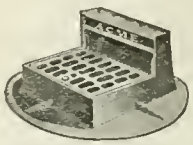

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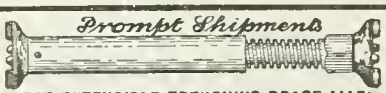

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Motor Truck Operation and Accounting—85

MOVING A VILLAGE ELEVEN MILES BY TRUCK AND TRAILER

By W. A. Carpenter, Acme Motor Truck Co., Cadillac, Mich.

The developments of the past ten years in the automotive industry are almost startling, when one calmly reviews them. Tasks that a few years ago would have been called impossible and wild dreams, have been successfully accomplished by the truck and trailer. Practically everything movable has been moved, and almost daily we hear of some new triumph of automotive engineering. This is the story of one such accomplishment.

The Acme Motor Truck Company, of Cadillac, Mich., has just built a trailer of unusual design, that is being used in a unique and unusual job—moving practically an entire village a distance of 11 miles.

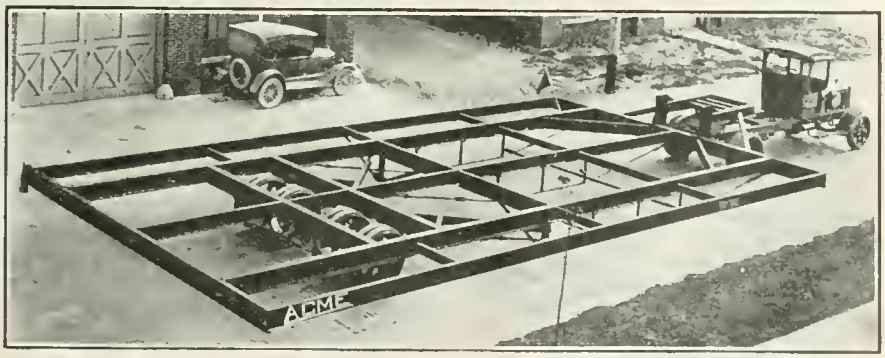
The town of Jennings, 11 miles north and east of Cadillac, was founded about a quarter of a century ago by the Mitchell Bros. Lumber Co. A saw mill, chemical and flooring plant gave employment to approximately 500 men. Jennings was a "company town," for, though it had a number of churches, "opera house," roller skating rink, community house, band stand, jail and other civic buildings, there was but one store in the village, that a general one, carrying all sorts of supplies, really a department store. About every able-bodied man in the village was employed in one of the three company mills.

When the village was founded the unbroken hardwood forests surrounded the village for miles and miles in every direction. A beautiful little lake nestled among the hills, the waters of which were alive with gamey bass, pike, perch of unusual size and many other varieties of fish. Life in the little village was very nearly ideal. The company paid good wages and the needs of the inhabitants were simple.

But as the years rolled around, the standing timber around the village gradually disappeared before the onslaught of the men with axes and saws, until a few months ago the last of the big trees fell, and then it was only a question of time when the fires in the boilers would be drawn and silence fall over the mills.

Various plans were considered for the preservation of the industrial life of the happy and contented little village, but all were discarded. Then was born the idea of moving the mills, the families and the residences to Cadillac, 11 miles southwest. Many plans were considered and rejected as impractical before the motor truck and trailer was considered. Acme engineers studied the problem from every angle, then finally W. A. Kysor, president of the Acme Motor Truck Company, submitted a report to the lumber company which was accepted, and the gigantic trailer illustrated in connection with this article was built.

The next thing to be considered was the road over which the 30 to 45-ton load would have to pass. About 8 miles of the distance is over the Michigan Trunk Line M55; the rest of the way over a fairly



VIEW OF TRUCK AND TRAILER DESIGNED AND BUILT BY THE ACME MOTOR TRUCK CO. OF CADILLAC, MICH., FOR MOVING THE VILLAGE OF JENNINGS TO CADILLAC, A DISTANCE OF 11 MILES.

good dirt road. Considerable work had to be done on this highway, the roadbed widened at a number of points, and in all cases of this kind heavy planks or timbers were laid smoothly to make a level roadway. A bridge across the Clam River was widened and reinforced. In the village entire streets were paved with heavy green planks to sustain the weight of the load, as the soil there is largely loose, soft sand.

The houses to be moved vary in size from 24x30 ft. to 24x40 ft. Many of them have hardwood floors, all are a story and a half high, well-built, comfortable and arranged for convenience. The weight of the houses varies from 15 to 35 tons. The windows are left in all of them. So perfectly does the trailer function that there

RESIDENCE OF THE JENNINGS VILLAGE MARSHAL EN ROUTE FROM JENNINGS TO CADILLAC. SIZE OF HOUSE 24x40 FT.; WEIGHT ABOUT 35 TONS.

is not the slightest jar in any part of the journey and not a window has been cracked, except in passing through the City of Cadillac, when the limbs of shade trees along the street broke one or two when the first house was brought in.

The 11-mile trip is made in about 4 honrs, which includes all necessary stops to wait for traffic to pass before entering upon a stretch of road too narrow to allow passing, though the actual running speed is from 5 to 8 miles per hour. Loading and unloading and passing through the city requires a longer time than that, as it is often necessary to remove the electric light and telephone wires to allow the house to pass under.

At the time this article is being written the rate of moving is about two houses every three days or four per week, although as the crew doing the work grows more accustomed to it, it is thought a house a day will be brought over. There are from 75 to 100 of these residences to be moved, so the work will require all of the rest of the year, although there is a possibility that an early and heavy fall of snow may retard the work and make it necessary to complete the project in the spring of 1923.

The flooring and chemical plant will also be brought to Cadillac, which will result in an increase in population of that city and make additional homes necessary, there being at the present time a shortage of houses in the city.

Many of these houses are being sold at a very reasonable price to workingmen, making it possible for a man receiving average wages to own a very comfortable home, with all modern conveniences, for considerably less than $2,000.

So Cadillac gains two important industries, from 75 to 100 new houses and from 500 to 1,000 added population, at the same time.

The Trailer

A technical description of the trailer follows:

The trailer is constructed with a framework of heavy structural steel beams. A channel and I-beam platform, raised 18 ins. above the trailer frame and rigidly connected to it, transfers the load at the forward end of the trailer to a rocking fifth wheel mounted on the truck. This construction eliminates all twisting stresses from the trailer proper.

The trailer frame is supported at the rear by four steel truck wheels abreast, equipped with solid rubber tires. These wheels are placed under the trailer in such a position that approximately 75 per cent of the weight of the trailer and load is carried on them, thus making it possible to carry a very heavy load on the trailer without overloading the truck used for motive power.

The trailer is designed to carry safely a maximum uniformly distributed load of 35 tons, and the complete unit weighs approximately 5 tons.

Frame.—The trailer proper is 24 ft. wide by 42 ft. long. It consists of five longitudinal members of heavy section structural steel, securely held in place by two main and four supplementary transverse beams. Diagonal cross-braces are built into the frame to distribute the stresses where excessive weaving and twisting would occur. To give added rigidity and strength to the structure the three center longitudinal members are reinforced with large truss rods securely anchored to the member at each end and supported at equal intervals by cast-iron struts. The tension in these rods is equal-

ized by a series of turnbuckles. All frame connections, gussets, braces, etc., are hot-riveted, the entire frame reflecting the skill of the structural workers.

Front Support.—The platform at the forward end of the frame is raised 18 ins. above the trailer. It is constructed of channels, I-beams and plates, and substantially braced with diagonal members to the forward transverse member of the trailer proper in order to eliminate side sway. This platform is connected to the trailer frame by means of heavy gusset plates and channels of sufficient strength to transfer safely approximately 25 per cent of the weight of the trailer and load to the rocking fifth wheel mounted on the truck.

Running Gear.—At the rear the trailer is carried on four cast-steel truck wheels, all abreast, equipped with 40x6-in. dual truck tires. The wheels are arranged in pairs, each wheel operating on tapered roller bearings supported by a tubular steel axle shaft. The shafts of each pair of wheels are bolted together at the center through a large steel casting, which is supported by an extra heavy wrought-iron pipe extending through it and at right

MOVING A HOUSE 11 MILES BY ACME TRUCK AND TRAILER.

angles to the shaft. Heavy steel pillow blocks at either end of this pipe support the weight of the trailer and load through coil springs attached to the trailer frame. This unique construction not only cushions the load, but successfully provides for road inequalities, which is very essential when taking into consideration that the distance between the outside wheels is approximately 11 ft.

To relieve the springs from driving stresses a radius rod with flexible connections is provided for both sets of wheels, the forward end of which is secured rigidly to the trailer frame and the rear end fastened to the end of the wrought-iron pipe through a swivel connection.

In order to maintain perfect alignment of all four wheels, the wrought-iron pipes supporting the axle shafts are tied together by a system of flat bars secured to the trailer frame and so arranged as to compensate for spring deflection.

The distance from the top of the trailer frame to the ground is approximately 40 ins. when the trailer is loaded.

Method of Loading.—The house is raised by a series of jacks located at each side. The two outside longitudinal members of the trailer, which are bolted on, are removed. The trailer is then backed under the building and the house is lowered until it rests evenly on the trailer frame. The side members are replaced if it is found necessary, and the unit is ready for its journey.

Motive Power.—Acme Truck Model 125 Chassis is furnished with this trailer. It is equipped with a Continental Motor which develops 55 H. P. actual brake test. This power, together with a gear reduction of approximately 71 in first speed, delivers a tremendous torque at the rear wheels, which is proven by the fact that we were able to negotiate a 6 per cent grade 600 ft. long over gravel road with a 35-ton load on the trailer.

RECENT DEVELOPMENTS IN MOTOR BUS TRANSPORTATION

By G. A. Kissel, President Kissel Motor Car Co., Hartford, Wis.

After an investigation of the inter-city motor bus lines operating in different sections of the country and a comparison of the results with those factors that created the necessity for this means of transportation, such as inadequate railway facilities and railroad equipment, one can not help being impressed with the fact that the motor bus as a passenger transportation unit has hardly touched the surface in the field of inter-city passenger transportation.

I understand that most leading centers have outgrown or are outgrowing local transportation facilities. The automobile has made this up to a great extent but the automobile is limited as to passenger capacity, while in most cases a conveyance or vehicle designed to carry a number of passengers on a prescribed route or schedule is what is needed.

Not only is this lack of transportation

felt severely between centers but even between states, and it would seem that these needs must be filled by other carriers than a street railway and railroad, because these requirements have been in existence for several years and as yet no concerted action has been taken by the public carriers to eliminate it. Thus was created the necessity for a motor transportation unit that could step right into place and begin operating without waiting for the construction of a right of way, or confining its operation to a prescribed route.

A survey throughout the country will show that practically every metropolis as well as cities and small towns are connected by motor bus routes and each year has seen an increased patronage by the public. Indeed, this increase has been so consistent that many motor bus companies have built up properties in the way of service stations, passenger depots, waiting rooms, etc., that are the equal of many railroads.

This public acceptance, which was remarkable at the very start of the motor bus entrance as a public utility, is indicative of the business that can be built up if the units are comfortable, attractive, safe and speedy.

We all can remember the first busses that were built—with a truck chassis and motor and a body built high up. decidedly awkward in appearance, uncomfortable for passengers and uncontrollable for the driver.

With true American ingenuity and inventiveness, motor bus makers have lately been showing rapid improvement, both in mechanical engineering and in body design and equipment. Today in some sections of the country, the busses are just as comfortable and attractive and up-to-date as are railroad parlor cars. Especially is this true in those scenic sections where railroad facilities are not as plentiful as they are in other sections and where overland transportation must be depended upon to a great extent.

Manufacturers and their engineers have solved the motor bus problem by building the body low over the chassis and giving them sufficient live weight with proper weight and balance that absorb the irregularities of the road, and by padding and upholstering the seats have been made very comfortable and not hard at all to enjoy even on long distance journeys. Without going into detail concerning busses of this character, I have often wondered whether it was really necessary to design and build such a heavy vehicle in order to attain maximum riding comfort and roadability.

The result of all our investigations along these lines, we boiled down to the essential factors around which we built the new Kissel Coach Limited for urban use, and which are as follows: 1, parlor car comfort; 2, perfect roadability; 3, the safety feature; 4, ease of traffic control; 5, proper speed; 6, operation and maintenance economy.

Every one of these items is found in the automobile of today, especially in the limousine or sedan type and we held that if we could build a sedan along the lines of the Kissel coach sedan, but accomodating 18 passengers, we would produce the ultimate in motor bus design and development. We felt that we would be giving the public touring pleasure with sedan comfort, and that the public would be quick to appreciate the advantages of such de luxe accomodations and would be perfectly willing to pay the increased cost.

Investigation among leading bus owners brought forth the fact that the public was perfectly willing to pay for de luxe travel on runs over 25 miles. In that case we believe motor bus operating companies as a whole will find it profitable to add to their present fleet a sufficient number of de luxe units to operate on a regular urban schedule but at a higher cost to the public. In other words, they would be offering the public parlor car accomodations. While the bulk of the traveling public prefers the day coach, there is a big proportion of the public that is willing to pay a slight increase in cost to secure the ease and relaxation as well as pleasure and satisfaction of the parlor car. It is also estimated that the use of such a class of vehicles as the Kissel coach limited would quickly create a desire on the part of the public for first-class motor bus accomodations which in itself will do a great deal to make the motor bus not only a recognized means of public transportation, but also what is still more important, a permanent public utility.

HOW HIGHWAY OFFICIALS CAN CHECK UP TRUCK LOADS

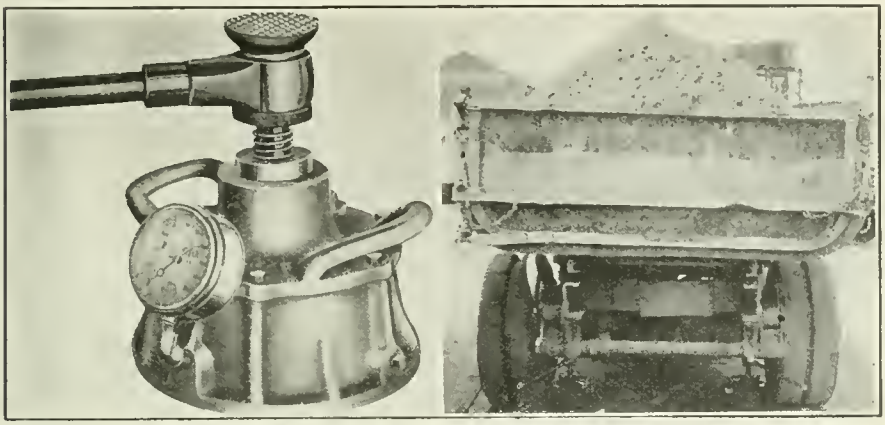
It has been a problem with state and county highway officials for the past few years to devise a scheme to determine whether or not their truck overloading laws were being complied with. They did not know just how to go about checking up overloaded trucks in an efficient man-

ner. In some states standard platform scales were installed on main highways, and for a while they seemed to solve the matter, but soon truck operators who intentionally overloaded their trucks would locate these scales and would detour them. It was soon obvious that some other method was necessary for determining truck loads on the highways.

A few years ago a portable weighing device was brought out in the form of a loadometer. The loadometer resembles a jack with a cylinder filled with oil, which supports a piston, on which the load is applied. There is a high pressure gauge connected with the oil chamber, on which the load is registered. The instruments can be conveniently transported from one place to another, as they weigh only approximately 40 lbs. each. A number of highway officials, who were trying to find a means of telling whether their overloading laws were being complied with, soon saw that these portable weighing devices were just what they had been looking for.

Several states started out to check up the loads traveling over their highways, and in the state of Maryland 150 trucks were found overloaded during the first week of the campaign. This was a big benefit to the truck operators, as in a number of cases they were ignorant of the fact their trucks were loaded beyond capacity, and were unconsciously abusing them. It has been quoted by a large truck operator on the Pacific coast that 20 per cent is taken off the life of trucks and tires that are constantly loaded beyond their capacity. He further stated that any employe of his was discharged on the spot who either overloaded his truck or drove at a speed exceeding 15 miles an hour. There is also danger of brakes not being able to hold when an overloaded truck is coming down a steep grade and the life of other people on the road is jeopardized.

The portable weighing device can be used on any highway and at any point on such highway, and truck operators who intentionally overload do not know when and where to detour to avoid the loadometers. The highway officials, with the use of these instruments, are educating the public to load their trucks within reason, which makes the highways better and safer for all who use them.



VIEWS OF THE LOADOMETER FOR WEIGHING MOTOR TRUCKS AS A MEANS OF PREVENTING OVERLOADING.

NEW YORK CITY BUYS 128 MORE WHITE TRUCKS

A contract for 128 5-ton motor trucks, just awarded by the City of New York to The White Company, Cleveland, following a previous order for 212 trucks of this make some time ago, gives The White Company the two largest orders for motor trucks ever placed by a municipality and gives the street cleaning department of the City of New York the largest known fleet of standardized heavy duty trucks.

Specifications required bidders to produce verified records showing at least 100 heavy duty trucks which have covered more than 75,000 miles. This requirement was a simple one for The White Company, which qualified in this respect two years ago.

One hundred and twenty of the trucks will be equipped with power dumping bodies developed especially for refuse collection under the conditions existing in New York. Each will carry 6 cu. yds. of refuse. They will be used for all phases

of street cleaning work, including the removal of ashes, garbage and snow. Six will be provided with winches and two will be equipped with apparatus for handling wrecks.

New York City has found motor trucks essential in keeping its thousands of miles of streets in a sanitary condition. The city has a nation-wide reputation for clean streets, and because of the constant growth of the street cleaning problem, large investments in motor equipment

TYPE OF WHITE HEAVY DUTY TRUCK PURCHASED BY NEW YORK CITY FOR STREET CLEANING WORK.

have been necessary. To protect the city against the blocking of thoroughfares by heavy snowfalls, such as happened two years ago, when New York traffic was paralyzed for days, a method of attaching snow plows to the front of the trucks was developed, and, on short notice, the city can throw into service a great battery of snow fighters.

THE HIGHWAY AS A LIVING FORCE

By Pyke Johnson, Secretary Highway Committee, National Automobile Chamber of Commerce, 366 Madison Ave., New York, N. Y.

If there is any one fact which should be impressed upon the people of America today it is that we can no longer think of the highway merely as a material thing. The highway is a living force which serves to bind the people of this country more closely together, which stamps out isolation and heightens our standards of living. Into its building and use go all of the elements of romance and adventure which the railroads had in the olden days, and it is only as we emphasize anew these phases of the highway question that we can hope first to instil an esprit de corps in the men who are carrying on the work today and second to appeal to the youth which will cause him to turn to the work tomorrow.

How many men are there today who can look back to the time when, as boys, they sat on the old rail fence watching the trains go by and pictured themselves as the ones who would handle the throttle of the engine in the future? How many men are there today who have read far into the night with bated breath the stories of those days of adventure when the pioneer gangs of the railroads broke their way through the wilderness for the steel rails to follow, and how many men are there today who realize that in highway transport they have at their very threshold the same opportunities for romance and adventure, the same opportunities for civic betterment that the railroads carried with them in the old days?

How many men know that today the road highway gangs of the states and government are traveling on snowshoes in the northern country, surveying the way for the highways to come; that other gangs are hanging suspended from high cliffs over rushing waters that the highway may be broken along the canyon's side; that throughout the Western country men are forcing their way through virgin forest in order that means of communication may be opened up? How many men know that in the use of highways China is finding a means of prevention of famine? Brazil is opening up a vast new empire of hard woods and produce, while in our own country on every side the building of new highways is infusing new life into communities deadened by loss of trade transferred to other communities more fortunately situated through forms of transportation.

In our own country transportation has always been a decided factor in our advancement. Those who recall the story of the first settlement of the United States know that postal development came first because of the need for retaining communication with the mother country. Inland waterways were the first channels of communication with the interior and these were followed by the beginnings of a national highway system in the early construction of the National Pike. The advent of the railroad checked this development and for a period of more than a hundred years we find that the economic zones of commerce in this country have depended largely upon the railroads which, generally speaking, pushed from the east to west and from north to south.

In all of the thousands of years of

development of transportation there was no real progress in highway transport until the advent of the motor vehicle 27 years ago. Until that time the transportation vehicles of the ancients were practically as efficient as those of the modern farmer. Searchers in archaeological records of the past discovered in a tomb 4,000 years old a wheel with a demountable rim, and aside from a few refinements in the wagon and a better breed of stock no real advancement was made in all this period. Then came the motor vehicle. Twenty-seven years ago there were four of them in the United States. Today there are more than ten million cars in the United States, or one to every ten persons or to every two and a half families. In many cities the average is so low that the entire population of a community could be transported at one time in motor vehicles. What the future may hold for further development no one can say, beyond making this one statement, that every normal man and woman is a potential prospect for the automobile salesman because of that inherent desire for individual transportation which first finds its expression in the youth sitting on the rail fence watching the trains go by.

However, there are those who prefer to consider these questions from a standpoint of their effect on economics, and for this class I would suggest that what we are dealing with here is a fifty billion dollar industry—transportation.

What is the future of this great industry? What are the problems which it brings with it, what is the field of opportunity which it affords to the youth of the country? Twenty-five years ago the major problems of transportation seemed to be solved. The imposition of a vast, heavy mode of traffic on our highways, with its enormous development and its immense requirements of all kinds of raw material, its acceleration of all other forms of industry have changed all this. New and intricate questions are present from all sides and it is perhaps enough for the purpose of this discussion to indicate only a few of the more important.

The first question to be answered is whether or not there is need for a highway in any given location. Does the economic welfare or the imponderable benefit to be derived by the community require its construction? What do the surveys and traffic data show? What changes should be made in the highway itself? What saving can be effected in the traffic over the highway through new gradients, banked curves and other refinements of modern highway construction to reduce tractive and power resistance? What means shall be found for the financing of this undertaking, larger than any other domestic activity of the government?

Political boundaries are no barrier to the cruising radius of a motor vehicle. A local community can not be expected to bear the full expense of maintenance of rights of way for travel which might originate and end entirely without its jurisdiction. From the standpoint of the general public, is it well to thrust a burden of taxation upon a unit of transportation which in one of its aspects alone, that of the excise tax imposed by the federal government, reaches a total today greater than all the tax paid by all of the corporations in the United States prior to 1916. How far is its economics to go in the imposition of motor registration fees, $108,000,000 of which were collected for the first six months of last year, according to the figures of the Bureau of Public Roads, or, putting it another way, $6,000,000 more than was collected throughout the entire year of 1920, always remembering, however, that collections are far greater in the first half than in the last six months of the year.

What is to be done regarding the administrative control of the highway, both in construction and maintenance, as well as operation? Can this question be left long a local unit when it is indicated the use extends beyond local bounds? It would appear that systems of highways will be necessary. How are these systems to be finally selected and classified?

Another question which must be answered is that of the responsibility of locating and financing our main highways. It is obvious that where traffic is generated in one county, runs through another and has its terminus in a third county, the second county does not receive much benefit, but its roads are used.

The same statement is true with reference to states, particularly in the east where much of the traffic across Connecticut and New Jersey, as outstanding examples, comes from other states. Quite obviously it is unfair to expect the county or state so used to bear the largest part of the burden and we should have overhead funds which could be devoted to the improvement of particular stretches of highways which serve more than local needs. In these cases it would seem that

the funds should come from a state source and should be expended under the state direction.

The task of taking care of the local highways is a large one and assistance of this kind would come as a welcome relief to county officials already overburdened with demands of more miles of roads than they can build within a reasonable length of time.

The whole question of our road program is a question of education, money and time. If we hope to see the road program completed in ten years, we should be ready to expend at least $100,000,000 from our national treasury and to maintain the present state and county programs at their present levels.

If we want to wait 15 years for the job, we must cut the federal figures to $75,000,000; if we want to wait 20 years, we can cut the amount to $50,000,000. But if we do wait we will pay a heavy penalty in excess of transportation costs and many of us will not live to see the job done.

The question of traffic control has become a major one in many cities. It extends also to the rural use of the highway. It involves even the very physical contours of metropolitan development and always it carries with it major questions of safety which must be solved.

Then we have again that other question of the interrelationship of transportation. What new form of development are we coming to in intrastate traffic? Is the terminal to be continued? It appears that the modern development of the motor truck is to supplement the rail lines, to take from it those short hauls which have been unprofitable, or perhaps for the railroad itself, and this seems a more logical conclusion, to use both forms of carrier. What is the field for this development? Where do the highway transport vehicles stand in relation to the waterways and the electric lines? All have their economic place. The question is its development.

So the inquiry might be carried on—questions of construction, of maintenance, of operation, of financing operation—all these point heavily to the none too plentiful resources in trained men available today.

Thousands of men will be needed in the future in all phases of this great problem of highway transport. The field is a vast one limited only by the range of human communities. It transcends the question of development of this country. It penetrates into every section of the globe. In it is afforded a place for the young man and a place which calls for service of the highest type, and it will not be until we have arrived at a thorough understanding of these questions of the development of highway transport that we can hope to reach the ideal of a quickened America which only the highest type of transportation facilities can afford.

THE FIELD FOR LIGHT, FAST TRUCKS

Before deciding to enter the light delivery truck field with the new Fast Express, the Federal Motor Truck Company conducted an exhaustive investigation into the country's requirements for lighter capacity trucks.

This investigation revealed that 65 per cent of all trucks in use are of 1-ton capacity or under. In many businesses, a considerably larger proportion are of this popular size. For instance, over 80 per cent of the trucks used on farms are of this size.

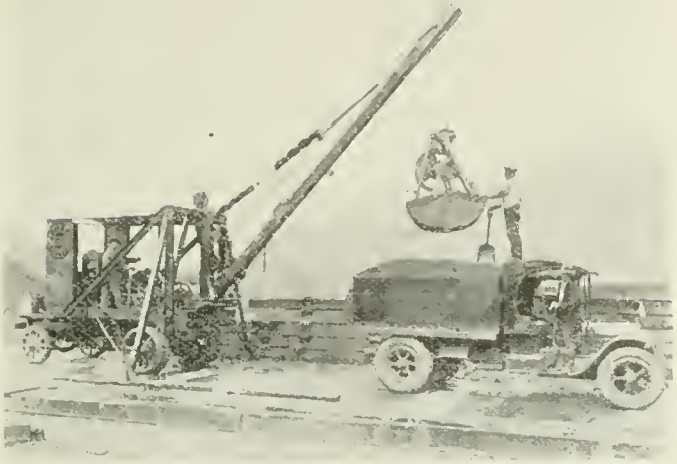
The Federal investigation also revealed that there is a constantly increasing demand for lighter and speedier trucks. The biggest demand at present comes from farmers. There are 6,448,343 farms in the United States. Of this total 2,673,331 are farms of 100 acres or more. Ultimately there will be required at least one light truck for each two farms of 100 acres or over.

There are hundreds of thousands of smaller farms given over to fruit growing, truck gardening, poultry raising and the like, on which the high value and perishable nature of the crop produced per acre make motor transportation to market most economical and necessary. In view of these statistics, the Federal company believes it is more than conservative in estimating that at least one truck will be required for each four farms in the United States, or a total of $1,500,000 trucks.

MOTOR TRUCK MOUNTING FOR BYERS CRANE

A big forward step in "taking the crane to the job" has been made by The Byers Machine Company, of Ravenna, Ohio, in bringing out a crane that can be mounted permanently on a motor truck.

The new outfit, called the "Byers Truck-rane," can be driven from the garage to



THE BYERS "TRUCKRANE," A MODIFICATION OF THE AUTO-CRANE ADAPTED FOR MOUNTING ON A MOTOR TRUCK.

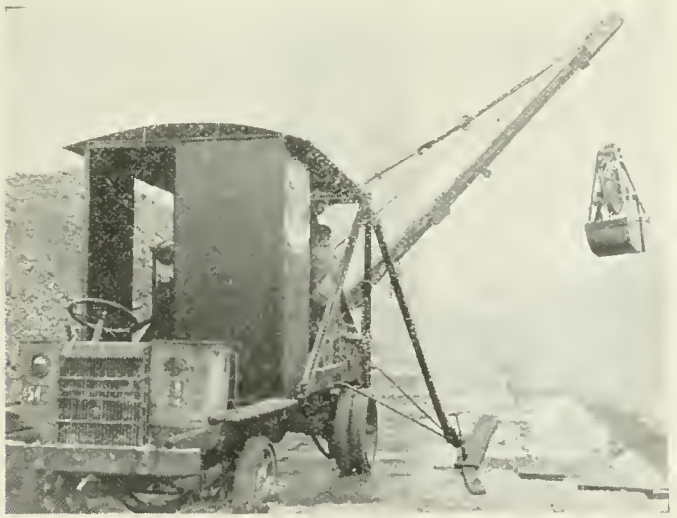
the job every morning just like any automobile, or driven from one job to another with a minimum of time lost in travel.

In addition, its increased "movability," together with the strength and comparative lightness of the unit, open a new field of crane service. Owners whose work has hitherto been too limited to operate a large crane, can, it is believed, use a machine of the "Truckrane" type at a profit. It should prove an ideal piece of equipment for general contractors, material and supply dealers, counties, municipalities and industrial plants.

The crane, unmounted, weighs only 6 tons, and is similar to the Byers Auto-Crane Model "1" in every respect, except that it has no wheels, jackshaft nor differential and drive chains. It has a power drum for raising and lowering the boom, which is of steel.

The crane is furnished with a Hercules 4-cylinder 4x5-in. engine, developing over 30 H.P., to be operated with gasoline power. Any half cubic yard bucket weighing not over 2,000 lbs. can be used with it.

It is not at all necessary to use a new



ANOTHER VIEW OF THE "TRUCKRANE."

truck for the mounting. One that has seen 90 per cent of its usefulness, having a motor that is capahle of turning over, is all that is needed. Bargains in half-worn-out motor trucks can be had everywhere, making the first cost of a complete outfit extremely reasonable.

The "Truckrane" shown above is owned and operated by The Worth Motor Service Company of Chicago.

The Byers Company has already started the erection of additional buildings and machinery required to manufacture the "Truckrane" on a large production basis without any interference with their standard lines of "Auto-Cranes," revolving cranes and hoists.

EQUIPMENT DIVISION OF NEBRASKA DEPARTMENT OF PUBLIC WORKS

The Equipment Division of the Nebraska State Department of Public Works occupies eleven acres of land in the city of Lincoln where machinery and equipment is stored and repaired and sold and rented to contractors and counties all over the State. Two large, commodious buildings have been erected on this tract, a warehouse 250 ft. wide by 500 ft. long and a repair shop 150 ft. wide by 285 ft. long. These comprise the only buildings and are not sufficient to store all the equipment as many of the trucks and tractors are kept outside in the yards. The matter of storage is not serious, however, because this stock is being continually changed by disposition and replacement. Procedure of the Equipment Division is described as follows in a recent issue of the Monthly Report of the Department:

The Government trucks are of the 2-wheel-drive type and of well-known standard makes such as Federal, Packard, Garford and Liberty. The market value of these trucks ranges from $3,500 to $4,500, but are transferred to the counties for road work for $1,000 to $1,500. Of course most of these trucks are not new, but many are practically so, and others will render much good and substantial service. The best trucks are being rapidly picked over. The State reserves the right to refund the money and call in a truck at any time. This is done when the trucks are being used for other purposes than provided, and not for legitimate road work. Not only are trucks let out, but they are also rented to the counties or to contractors on State work for $9 per day. This often allows the county the use of the truck without so large an expenditure of money.

The Holt 10-ton "Caterpillar" tractor is leased for $3,500 and rents for $25 per day. The 20-ton tractor leases for $2,600 and also rents for $25 per day. The trucks are used for light maintenance and graveling and the tractors are used for heavy construction work. Practically all the trucks purchased by the counties are secured from the Equipment Division. Heavy grade Veedol cylinder oil is sold for 75c per gal. in 55-gal. lots. Other equipment sold for road gangs include:

Elevator Graders	$750.00
High Speed Trailers	$250.00
Bunk Houses mounted) 9½x20	$250.00
Bunk Houses (in sections)	$ 35.00

About 40 of the mounted bunk houses have been disposed of in the last three years. The bunk houses are rented to engineers and contractors for $1.00 per day. To help furnish these outfits, the Division sells the following:

Tarpaulin	5c and 6c per foot
Mattresses	$4.50 to $6.00 each
Blankets	$1.50 to $6.00 each
Pillows	$1.50 each

An unlimited supply of equipment is on hand for the use of the engineer in the field such as transits, rods, chains, tape, etc. These are checked out to the engineers when they leave for their projects. Dodge and Ford cars are rented to them at 12 cts. per mile exclusive of repairs. Dynamite for blasting is on hand at 25 cts. per pound in small quantitles. In larger quantities, reductions are made. Caps for the dynamite sell for 2 cts. each and fuses at 2 cts. per ft. This concentration of field equipment in large quantities in one place not only lessens expense but saves time in the transmission of supplies to the engineer.

Repairs for all equipment sent out are made at the repair shop and the counties are billed for it. All is done at minimum expense; 36x6 in. solid tires for trucks are pressed on for $20. A machine for acetylene welding has been installed. The recording of repair parts on hand is facilitated by the use of a perpetual card invoice system. This expert repair work at reduced rates is another saving to the taxpayers in their road building.

The Equipment Division is under the supervision of Mr. A. W. Moffitt who has been in charge as superintendent since 1919.

EDITORIAL

ORGANIZATION AND THE ENGINEER

Probably the public is giving more thought to the "labor question" now than ever before; at any rate it seems so. It seems, also, that people are seeking the truth with unusual efforts to put prejudice aside. Very few people have reached settled convictions on the subject, but there are certain signs that out of all the deluge of discussion a few fundamental principles are being isolated and agreed upon. The engineer, standing between capital and labor and familiar with the ambitions and problems of each group is in a good position to assist in the establishment of equitable industrial relations, and he has no public duty higher than this.

To us it appears doubtful if society can continue to tolerate a condition where certain classes are organized while others remain unorganized. The statement that the American Union could not exist half slave and half free will be recalled. The truth of this statement was established. Is it equally true that society cannot continue to exist half organized and half unorganized? If it is, then one of two things must happen—either everybody must get into an organization to safeguard his selfish interests, or all such organizations now existing, whether of labor or capital, must be abolished by due process of law. It seems obvious that if all were organized there would be no advantage to any individual or class for the advancement of any group would immediately be nullified by the advancement of all other groups. At present there is an advantage in organization only because so many classes remained unorganized. The organized advance at the expense of the unorganized. Why should this be and how long can it continue? What answers will the engineer make to these questions?

REAL ENGINEERING COOPERATION

In a recent issue of the Journal of The Western Society of Engineers the following statement was made by an officer of the Society: "A member of a profession such as engineering should feel it his duty to assist fellow members in all matters relating to their professional advancement, as by so doing he contributes to the success of the profession as a whole." Probably all engineers will applaud this statement, but how many observe this precept as a guiding principle in their conduct toward other engineers?

We believe that one feasible plan for increasing the compensation of all worthy engineers is for the chief to advance his subordinates if he can and when he feels they deserve advancement. The chief engineer who considers it a major part of his job to keep down the cost of conducting his department and saves at the expense of all his men is holding himself down at the same time, for anything he does to cheapen the value of engineering service is bound to react on himself. If the chief is alert in the interest of his really worthy surbordinates he is looking after the best interests of his employer and himself.

MAKING ZONING PERMANENT

Zoning ordinances for the regulation of use, height and area of buildings are being adopted by cities in almost every state in the Union, and in some states where there is no specific authority for zoning these ordinances may be set aside by the courts. An enabling act is advisable in all cases.

A standard law for the assistance of those responsible for the framing of state zoning enabling acts has just been issued by the Department of Commerce, Washington, D. C. This model enabling act is a 20-page mimeographed pamphlet with foot notes covering questions which may arise in the wording of various sections and provisions. It should be noted that this is not a federal law but is a suggested form for state enabling acts.

Those who have made any sort of study of political reactions will probably agree that it is easily possible that a city might adopt a zoning ordinance and repeal it after a change in administration. In a year of discontent a mayor and council might be elected on a general "anti" platform including, incidentally, an anti-zoning plank calling for the repeal of the zoning ordinance. If the ordinance had been in effect for some years and had been accepted in good faith by many builders its repeal would work a real

hardship on them. As this, or anything else, can easily happen in almost any locality when made a political issue and joined with other issues in a manner to confuse the electorate, it seems very desirable to safeguard zoning laws and ordinances against easy repeal. It should be made very difficult to repeal zoning regulations, although their reasonable modification should be made comparatively easy.

An enabling act is always advisable. It is frequently assumed that the powers contained in Home Rule Charters are sufficient to enable a muuicipality to undertake zoning. This is often a mistaken belief and some zoning ordinances have been set aside because the municipality had not been granted the specific power to do what zoning implies.

It is understood that the Department of Commerce is now giving careful study and attention to a group of typical zoning ordinances and is considering the preparation of a standard ordinance or parts of ordinances. It is expected that a supplementary publication on this subject will be forthcoming.

AN EXPENSIVE SOURCE OF REVENUE

Some cities, desperately in need of money, have had recourse to a very expensive source of revenue in the shape of taxing visiting motor trucks. It is appreciated that the tax rate is high in most, if not all, cities and the hard pressed officials must cast about for additional funds with which to pay the cost of running the city without still further increasing direct taxation, and one can sympathize with them in their predicament without approving of all the measures they adopt. It is becoming quite common to require trucks to pay city as well as state taxes and there is something to be said for this practice so long as the cities extend reciprocal privileges to their citizens. But when a man drives into a strange city in a truck and is pulled from his seat and arrested unless he buys a truck license issued by that city we do not hesitate to denounce the practice as an abuse of power that is unwise and very short-sighted. A better way of turning business away from a city could not well be conceived unless the police force is directed to order pedestrians to "stand and deliver." The practice is so abhorrent to all recognized usages of commercial intercourse and so contrary to all emotions of neighborliness and hospitality that to be condemned it needs only be mentioned. Let it be said to the credit of "business men" that they appreciate the folly of this practice and have made such vigorous protests in some cases that it has been abandoned or greatly modified.

THE TEACHERS OF ENGINEERING

Before sending his own son to an engineering college the prudent man will give thought to many things. He will consider the general reputation of the college as an over all check on its worth and as presumptive evidence of the presence or absence of the various attributes a college should possess. He will consider the physical plant, the number, size and type of buildings. He will consider the laboratory equipment available, and, if a college man himself, he is likely to give consideration to the text books used. But any one of these conditions, or all of them combined, will not weigh as heavily with him as the personnel of the teaching staff. After all it matters comparatively little what the school is called or where it is located, whether it is old or young, large or small, but it matters greatly whether its teachers are competent or not.

Too often teaching is left to immature instructors or impractical men of greater age, while those on the staff who are best qualified to teach young men spend their time in administrative or research work, or in "outside practice."

There is only one way to make reasonably sure of competent instruction, and that is by paying salaries that will attract and hold real masters. A professor's salary should be high enough to enable him to have the material things essential to artistic success. It should be high enough to attract successful practicing engineers, who are willing to make some sacrifice in income in order to secure the advantages of life and work in a college community, but who are not tempted at all by the scale of compensation now in vogue.

We believe the time has come to stop the "competitive armament race" between colleges in buildings and equipment and to begin turning much of the money so saved into higher salaries for the teachers. It is well to remember, always, that to a young person his teachers are second in importance only to his parents.

ASPHALTIC CEMENT SPECIFICATIONS

By Gene Abson, Chief Chemist, Chicago Paving Laboratory, Inc., 160 North Wells St., Chicago, Ill.

The importance of rigid specifications governing asphaltic cement is oftentimes given too little consideration, due, perhaps, to the fact that the average sheet asphalt pavement contains only about 10 to 11 per cent, by weight, of bitumen. Although this is true, perhaps more importance will be attached to its value if it is borne in mind that when considered on a volumetric basis, as is the entire theory of asphaltic pavement construction, this same 10 per cent by weight represents more than 20 per cent by volume. It is generally conceded by authorities who have studied pavement failures, that but a small percentage of disastrous results can be attributed to actual inferiority of the asphaltic cement; however, it is likewise thought that a large percentage of incipient failures and cracking of mixtures, considered alone, can be traced directly to the absence of sufficiently rigid and essential requirements governing the asphaltic materials used.

Some Worthless Tests

An examination of specifications from representative cities throughout the country, with special reference to cities where pavement troubles have been encountered, shows a tendency towards neglect of certain standard requirements capable of insuring quality, with a substitution of arbitrary and practically valueless tests. These latter are usually the product of some more or less inventive mind seeking recognition by radical departure from previous practice, and with no apparent reason or foundation based on theoretical or practical consideration; failure or compliance with these requirements means nothing. Particular reference is made to various bending tests conducted at temperatures ranging from 0 deg. F. on up, and upon which few operators can obtain concordant results; "freak" penetration and ductility tests made at temperatures other than accepted standards and offering no means of comparison with materials which have heretofore proven successful. The gradual widening and elimination of requirements, if carried on too far, will in time allow a material to be used by stating that it shall be of such-and-such a proprietary name, without a word governing its chemical and physical properties, as has been noted in at least two instances. Examination of the asphaltic material used in one of the above instances in a Western city showed it to be of an exceptionally poor grade and unfit for use as a paving cement, but its rejection was impossible. The unwise acceptance of a specification such as this will undoubtedly be evidenced within a year or two.

Aim of Low Requirements

In this list must also be included specifications sponsored by manufacturers whose only aim is to keep the various requirements as low as possible in order to permit the use of all grades and forms of their material, regardless of whether or no they are first-class. The conscientious producer, of course, is to be considered when specifications are being written, but only insofar that no undue limitations are imposed which would be prohibitive from an economic standpoint without in turn increasing the merits of the material. However, from this angle only is the producer to be considered, and in no case should quality be given a minor consideration for the sake of allowing competition by the manufacturer of an inferior product.

The Evil of Closed Specifications

Then, too, there are specifications promulgated by producers which are so drawn as to exclude all but their own product, of which supply the producer usually has the monopoly. This practice restricts competition with other brands of proven and recognized merit, and results in an increased price of pavement to the taxpayer, as has been demonstrated innumerable times in cities in which the specifications are "closed." In some instances it has been found that this practice has been due to ignorance on the part of city officials, rather than a belief that a particular brand was superior in quality, or a willful attempt to prevent competition for ulterior motives. Oftentimes specifications are "closed" in effect, but not in the eyes of a legal advisor, whose interpretation of the legality of such a specification is based on the assumption that the existence of a small quantity of some material which will comply with the specification constitutes an "open" specification, irrespective of the availability of the material for practical competitive purposes or whether it be no more than a scientific curiosity. Nevertheless, in every instance it has been found that cities soliciting bids under "closed" specifications invariably pay more for the same type of pavement than does a neighboring city for the same

brand considered in competition with others under an "open" specification.

The writing of specifications and the limiting of requirements for asphaltic materials is predicated upon several important considerations, namely, a thorough knowledge of the chemical and physical properties of the various bitumens which are in use as a source of supply for paving cements; an investigation of both successful and failed pavements for the purpose of determining which failures are attributed to the cementing medium, and provision for adaptability of paving materials to a variety of traffic conditions.

Asphaltic Cement and Flux Oil

The only specifications which are necessary, so far as bituminous materials are concerned, are for the asphaltic cement itself, and those governing flux oil where refined asphalt is being brought to the proper consistency. Clauses governing the refined asphalt are unnecessary for the reason that the asphaltic cement is the major consideration, and compliance with the AC specifications precludes the use of none but good quality refined asphalt. However, it is imperative that flux oil be tested separately, especially when used in small quantities, as it is usually extremely difficult to detect by laboratory tests the presence of an inferior flux after combination. It is only after the pavement has been in service for several years that this inferior product will be revealed, often by excessive cracking.

Testing Asphaltic Cement

The only requirements for an asphaltic cement, which are really essential, are that it shall be adhesive enough to cement firmly together the particles of mineral; be ductile enough to withstand the effect of expansion and contraction without losing its cementitiousness; be capable of resisting extremes of temperature by not becoming too brittle or too liquid; and not be unduly hard nor lose its cementitiousness by the volatilization of lighter hydrocarbons; and, of course, be of the proper original consistency for the pavement contemplated. These requirements, if properly covered by rigid specifications, will insure an asphaltic cement which, if handled properly and combined with the right proportions of suitable filler and aggregates, result in none but good pavements. For the control of these properties no elaborate array of chemical or physical tests is necessary; only the following are considered as having any direct bearing upon the quality of the asphaltic binder:

1. Penetrations at 32 degs. F., 77 degs. F. and 115 degs. F., for the control of susceptibility to temperature changes.
2. Ductility, or cementing value, for cementitiousness and adhesiveness.
3. Flash and volatilization, for determining the presence and quantity of lighter hydrocarbons, which reflect upon the effect of time on pavements in service.
4. Solubility, for determining purity, and care used in refining.

Testing Flux Oil

If the flux oil is to be tested apart from the asphaltic cement, as is recommended where used, the only tests which are necessary are:

1. Flash and volatilization, as in asphaltic cement.
2. Solubility, as in asphaltic cement.
3. Specific gravity, for control work in fluxing.
4. Asphalt content determination, with ductility of resulting asphalt, for quality, as in asphaltic cement. (Applicable particularly to asphaltic base residuums.)

An important consideration in interpreting the ability of an asphaltic cement to bind securely together the mineral particles, and one which it is believed is not thoroughly understood and stressed, is its susceptibility to temperature changes, especially at higher temperatures approaching the approximate maximum of the summer sun on a pavement. At present, a susceptibility factor which is used in several laboratories is evaluated by a ratio factor between the penetrations at 32 degs. F., 77 degs. F. and 115 degs. F., and which has proven of considerable value. However, it is thought that this factor can be more definitely established by a comparison of ductility values together with penetration values at higher temperatures, and it is planned to investigate the matter more carefully and interpret the results on a practical basis.

Identification Tests

Other tests quite generally found in specifications, such as fixed carbon, specific gravity of the asphaltic cement, presence or absence of sulphur, paraffine scale, etc., are merely tests of identification for various bitumens, but bear no relation whatsoever to the value of the material as an asphaltic binder.

The Open Cup Recommended

In passing, it might be pertinent to point out that at present there seems to be a tendency towards the adoption of a modified open-cup method for determining flash points, this being brought about on account of the wide discrepancy and in-

ability to compare the results obtained in the various closed-cup methods now in vogue. It is strongly recommended that the open cup be used entirely, employing a modified Cleveland cup in the form of the regular 4-oz. deep style tin, filled to the beading, which allows ample room for expansion of the material and accumulation of the vapors. The advantages of this method are ease of operation, especially where a large number of tests are made daily, as each determination is made in a separate container and discarded after completion; greater uniformity and more concordant results between different operators, due to elimination of personal equation and standardization of equipment; ease of interpreting results when standard has once been adopted. Under present closed-cup standard methods, which require that container be filled to within 5 mms. of the top, a determination becomes extremely difficult on account of overflowing as the material expands, resulting in widely varying flash points upon the same material.

Importance of Flash Point

Regardless of whether natural petroleum asphalts, or refined asphalts and flux, are used, too great stress cannot be laid upon the importance of the flash point and the volatilization determinations at elevated temperatures. Under present traffic conditions, particularly in cities where the pavements are subjected to a considerable amount of swift-moving automobile traffic, it has become necessary to design pavements using a minimum amount of bitumen with a maximum amount of fine mineral, making no allowance for gradual drying out and hardening of the bitumen, as has been previous practice in the days of lighter traffic, when comparatively rich mixtures were laid. Such a pavement laid now would be impracticable for the reason that rolling, rutting and general distortion would take place before the drying and hardening action showed its effect. If the flash and volatilization requirements are not made higher than has been previous practice, when the lighter constituents have volatilized, the mixture hardens and cracks profusely. Therefore, it has become necessary to use an asphaltic cement or flux which has been refined to the extent that all of the lighter constituents have been removed. Proof of the protracted cracking which takes place when asphaltic materials containing light constituents are used, can be found in pavements of the larger cities.

CONSTRUCTION OF REINFORCED CONCRETE SECTION OF LEE HIGHWAY AT PULASKI, VA.

By G. H. Derrick, Civil Engineer, Pulaski, Virginia

The town of Pulaski, Va., has just completed a reinforced concrete road extending from Washington Ave. to Pierce Ave., parallel with and south of the N. & W. Ry., known as "Dora Highway," and constituting a link in the Lee Highway. It is 1,154 ft. long, 18 ft. wide, 6 ins. thick at the sides and 7 ins. thick at the center. A 5-ft. sidewalk with curb and 2-ft. gutter extends the full distance on the south side, and a 4-ft. shoulder of old macadam on the north side gives a 24-ft. roadway.

This section of road has been macadamized for some six or seven years, and has had considerable repair work done on it, including surface treatment. Owing to the poor drainage and adjacent low land, it has given more or less trouble in the upkeep.

The Town Council decided to put in something permanent, and accordingly had plans and specifications, with estimate, made, with a view of doing this work with the local help and under the writer's supervision. An old "Smith" mixer on skids, calling for three set-ups, with two-wheel buggies, giving an average haul of some 100 ft., was available. A 1:2:4 mix, 1-course concrete, was used, having a 4-in. crown; assuming 3.8 cu. ft. to 1 bbl. of cement and 45 per cent voids, 1.57 bbls. of cement, 0.44 cu. yd. of sand and 0.88 cu. yd. of stone to 1 cu. yd. of concrete, we deduced the following quantities per lineal foot: 0.36 cu. yd. of concrete, 0.1584 cu. yd. of sand, 0.3168 cu. yd. of stone, and 0.5652 bbl. (or 2.26 bags) of cement. From the above we estimated 432 cu. yds. of concrete, 678 bbls. of cement, 257 tons of sand and 513 tons of stone.

American Steel and Wire Co.'s No. 049 triangular mesh reinforcement was placed near the bottom, and Carey Elastite, ⅜x 6-in. in 9-ft. lengths, was placed next to the old curb and joints every 40 or 50 ft.

First the old macadam was rooted up and removed, then using the gutter edge on the south and setting a 2x6-in. form on the north to the same grade, and with a template resting on both, the grade was trimmed and rolled to the correct subgrade. This gave the sub-grade a 3-in. crown. The forms were coated with auto oil secured at the garage from discarded washings of cars. A strike board was

made of three 1x10-in. boards spliced and shaped to the finished curve with a 4-in. crown, and shod with a strap iron, and suitable handles for the convenient handling by two men. As the concrete was placed, the strike board thoroughly tamped to the correct grade, bringing the moisture to the surface and forcing all stones down. This is very important to get a true surface, and cannot be neglected. The roller was made from a scrap 5-in.x5-ft. piece of steel pipe made into a convenient roller, with 20-ft.x¾-in. handle to be used from one side; this weighed about 75 lbs., and followed the tamping as soon as the concrete had gotten stiff enough not to roll out too much. This rolling forced down all small stone and left a wet mortar top. A 20-ft.x6-in. rubber belt then followed, first with one or two trips of zigzag 6-in. strokes, and lastly a final straight firm side stroke to the unfinished concrete. In case of a stop not requiring a Carey joint filler, the template was set and the concrete squared up. On starting again this board was simply removed, and the new work placed in contact with the old. As soon as the concrete had gotten sufficiently hard not to be defaced a few inches of dirt was spread over the entire surface and wetted. This wetting was kept up for about 10 days. After two weeks from the time the last concrete was laid the dirt was cleaned off and the street sweeper was run over the surface, and a good washing was given and allowed to dry over night. Then a treatment of Hard-n-tyte (magnesium zinc fluosilicate) was applied. First application consists of, by volume, 1 part of Hard-n-tyte to 13 parts of water—density 5½. Second application, by volume, 3 parts of Hard-n-tyte to 10 of water—density 15½. A Beaume Hydrometer was used to determine the density as noted above for each mixture: these were each mixed in conveniently placed barrels along the sidewalk and the solutions applied with buckets and brushes by hand. By the time the first application was placed (6½ bbls.), the far end was thoroughly dry and the second 4½ bbls. followed; 650 lbs. of the crystals were used, leaving about 75 ft. at the east end, with only one treatment applied. It was decided to leave this for a test to show the results.

The road was then opened to traffic just two weeks after the last concrete was laid, August 28, 1922. The actual concreting and moving was done in 10 days, and the best 10 hours' run was 147 lin. ft. The actual cement used was 666 bbls., or 57 sacks over the calculated amount for the exact number of square feet. It might be noted just here that the factor 1.57 bbls. per cubic yard is higher than most tables and that 1.48 is more commonly found for 1:2:4 mix and is more like a 1:2:3½.

The cost has been as follows:

666 bbls. of Cement	@	$4.00	$2,644.00
260 tons of Sand	@	2.10	546.00
520 tons of Stone	@	2.50	1,300.00
160 Labor	@	2.50	400.00
650 lbs. Hard-n-tyte			200.00
1,800 ft. of ⅜x6 in. Carey joint			200.00
5,400 lin. ft. 50-in. No. 049 Am. Steel & Wire triangular mesh reinforcing			400.00
Outfit and rental			100.00
Superintendence			400.00
Total			$6,210.00

Number of sq. yds.: 2,308. An average price of $2.69 per sq. yd.

The sand came from bank near Petersburg, Va., anda was clean and coarse. S.G.=2.63, Voids=38.6%, Silt=0. Screen test showed: 46% retained on No. 20, 71% retained on No. 30, and 99% retained on No. 100. The stone was local clean, hard limestone from ¼ to 1½-in.

ORNAMENTAL STREET LIGHTING SYSTEM AT LIMA, OHIO

By Elmer McClain, Director of Public Service, Lima, Ohio

The citizens of Lima are very proud of their new ornamental street lighting system, which cost them about $200,000 and which is the most complete and up-to-date in the country. It comprises 1,245 units, extending over 16.2 miles of lineal length and covers the entire down-town business section of the city and four principal residence streets. Petitions have already been circulated by property owners for several extensions.

The plans and specifications were drawn by Mr. Herman Gamper, Consulting Engineer, of Columbus, Ohio, following an inspection by Mr. Gamper and the Director of Public Service of some dozen ornamental street lighting systems in cities of the Middle West. The installation includes an underground system for ornamental posts operated from a turbo generator equipment in the municipal pumping station through constant current 6.6 ampere regulating transformers.

One of the most interesting features of the new installation is the graduation of candle power, mounting height, and spacing, in accordance with the requirements of the individual streets. In the public square the posts are 15 ft. high, with 1,000-candle-power lamps with special refractors, throwing the light toward the center of the square. On the main business streets they are 13 ft. 3 ins. high,

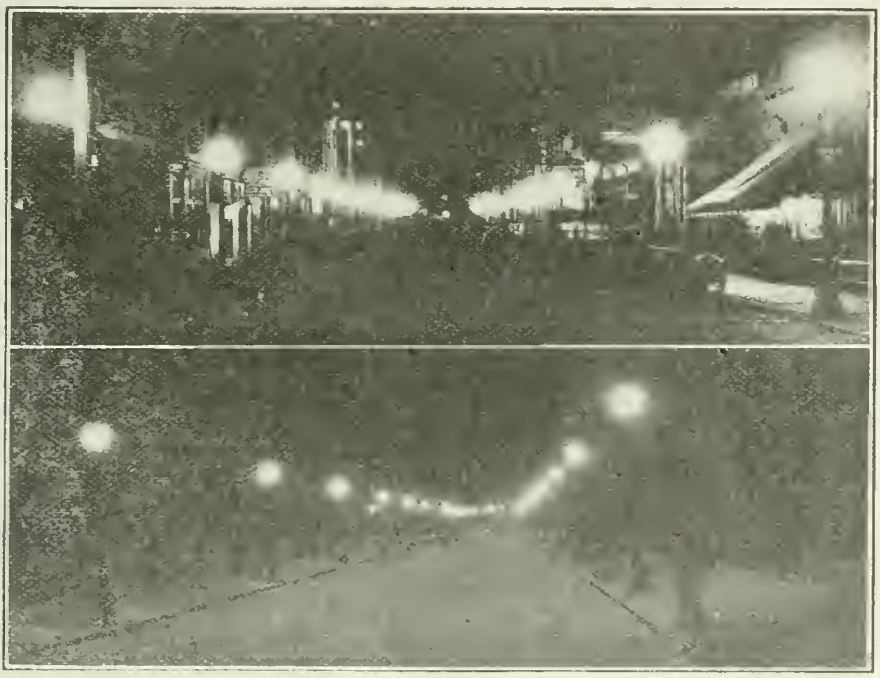
with 400-candle-power lamps. On the minor business streets and in the residence sections the height of the posts is 12 ft. 3 ins., and they are equipped with 250-candle-power lamps. In the down-town business section the standards are spaced 50 ft. apart. In the balance of the system the spacing is 100 ft. Much time and thought were devoted to the spacing and location of standards. Against the usual requests of individual property owners for the shifting of location, which has resulted in bad distribution in illumination in many cities, the Director of Public Service took a firm stand and insisted that each standard should go in as planned. The result is that the protesting property owners, as well as the citizenship generally, are delighted with the appearance of the entire layout and the uniform distribution of illumination.

In designing the installation the consulting engineer did not make the mistake of endeavoring to save on the maintenance of the units by cutting down the candle power of the lamps. This is poor economy in ornamental street lighting, because the saving in expense by the use of the lower candle-power lamps is very small as compared to the initial outlay for the installation, which remains practically the same for all candle-power lamps.

The contract for the construction work was let to the Northern Electric Company, of Columbus, Ohio, after very lively competition among some fifteen well-known bidders. In the installation, Hazard steel-taped lead-covered cable, for the underground system, and single conductor rubber covered and braided cable for the post wiring, were used.

Westinghouse-Cutler Continental posts were selected, equipped with Sol-Lux tops and Monax diffusing glassware. The lamps for 400-candle-power and upwards are operated through auto transformers in the capitals of the posts, and the 250-candle-power lamps are equipped with Regent "C" repeating film sockets.

The system, which is divided into 10 circuits, is operated from a turbo-generator set, supplemented in reserve by a Ball engine-driven 150-k.w. generator, in the city pumping station, through ten 34-kv-a Westinghouse constant current regulating transformers. Two circuits, extending throughout the system, including



TYPICAL VIEWS OF NEW ORNAMENTAL STREET LIGHTING SYSTEM AT LIMA, OHIO.

Business Street with Sol-lux Senior Tops on Continental Posts, 50 ft. Spacing, 400 C. P. Lamps with Auto Transformers. Cable in Sidewalk Just Inside Curb. Lima Makes Own Power and Uses Westinghouse Regulators and Lamps.—View on a Residential Street.

street intersections and the intervals between and alley intersections, are on all night. The remaining light circuits are turned off at midnight. During December, 1921, the consumption was 57,000 KWH.

A disconnecting pothead is installed in the base of each post, whchi, in the event of a post being accidentally broken, automatically disconnects the broken post, short-circuits the line, and leaves the rest of the lamps burning.

Westinghouse type "C" Mazda lamps are used throughout the system.

The alley intersections are lighted by special brackets, attached to the corners of the buildings, equipped with radial bowl street hoods, and operated from the underground system through safety coils. By this new installation, the necessity for unsightly overhead equipment has been eliminated, thus adding greatly to the appearance of the streets, hitherto cluttered up with overhead pole line equipment.

The impression of the graduated and harmonious illumination is very pleasing, and the stranger is able immediately to distinguish the importance of the various streets from the intensity of illumination.

STRENGTHENING GRAVEL ROADS WITH TAR SURFACE TREATMENTS AT ELGIN, ILL.

By Geo. E. Martin, Consulting Engineer, General Tarvia Department, The Barrett Company, 40 Rector St., New York, N. Y.

Elgin, Ill., is a thriving manufacturing and trading city of about 30,000 inhabitants, located some 40 miles west of Chicago. Elgin Township surrounds the city, and the major portion of the traffic in and out of the city of Elgin passes over the Elgin Township roads.

For a number of years this township has built gravel roads of pit-run gravel, which has been screened to remove the larger stones. The material as finally placed on the road ranges in size up to 1½-in., and contains a fairly large proportion, probably 30%, of material below ¼-in. in size. These roads have been built and maintained as plain gravel roads for several years, and the thickness of the gravel coating will vary from 8 to 15 ins. Up until a short time ago the gravel roads were maintained by the use of drags and blade graders. A new layer of gravel 2 or 3 ins. thick was placed on them every one or two years.

In 1920 Mr. Charles Burnidge, Township Road Commissioner, decided that he would try to use some sort of bituminous material on the gravel and maintain them as gravel roads with a bituminous crust or top. Previous to this time he had used dust-laying oil, and while it was successful in laying the dust, it did not strengthen the surface of the road, and Mr. Burnidge wanted something that would carry the heavier traffic in a more satisfactory manner.

Two roads, the St. Charles Road and South Street Road, were chosen for experimental work for the summer of 1920. Each of these roads was given an application of ¼ gal. per sq. yd. of Tarvia B in June, 1920. Because of the small amount of material used, the actual results obtained were only fairly good, but they were encouraging enough that the Township Road Commissioner was willing to go ahead and carry through this work in the season of 1921.

The St. Charles Road was scarified, reshaped and rolled early in 1921. It was left under traffic for about 4 weeks before it was treated. The South Street Road was not reshaped, but was simply left under traffic for this period. In June and July, 1921, the St. Charles Road was given two applications of ¼ gal. each of Tarvia B. The same treatment was applied to South Street, Dundee Ave., Highland Ave. and Kenyon Road. The time between the first and second applications of the Tarvia B was in some cases less than 24 hours, and in some cases was approximately 48 hours. The roads were closed to traffic while the Tarvia was being applied, and for the period between the two treatments. A cover of clean pea gravel using 1 cu. yd. to about 90 sq. yds. was applied soon after the second application of the Tarvia B. Immediately after the application of the cover the road was thrown open to traffic. No cover was used on the first application of Tarvia B.

Before the Tarvia B was applied the road was swept with a rotary horse-drawn sweeper. This work was done very carefully, so as to get practically all of the loose material removed from the surface, and still not disturb the bond of the road proper.

Preliminary preparation of the roads to be treated was started during the fall, and continued during the spring, when the roads were soft. The roads were gone over at frequent intervals with a light grader and all of the loose material worked toward the center, where it would be consolidated into the road by traffic. In some cases the crown is still somewhat

high for a bituminous treated surface, but because of the condition of the road it was not possible to remove all of the excess crown.

The 1921 surface treatments were entirely successful, and carried the traffic through the summer. In all, about 7 miles of 18-ft. gravel road in Elgin Township was treated with Tarvia B in the season of 1921.

During the summer these treated roads were maintained by a patrolman. As soon as a break in the Tarvia B surfaces appeared it was immediately repaired with Tarvia KP. In almost all cases the repair was made by brooming the Tarvia KP into the broken spot and covering it with pea gravel. By carrying on the work in this way and repairing the breaks as soon as they occur, it has been possible to carry the roads through with very few deep holes. Where deep holes have occurred, however, a mixture of Tarvia KP and gravel has been used for making the repair.

In practically all cases these roads have come through the winter in good condition and will not need to be reshaped before being given a surface treatment with Tarvia B this season. In case, however, the road does show considerable breaking up in the spring, it is an easy matter to break up the road with a scarifier and shape it down and permit it to consolidate under the traffic. When it is thoroughly consolidated it is then given a single treatment of ¼ gal. Tarvia B, covered with pea gravel, and is then in good condition to go through another year. Several new roads will be added to the list in Elgin Township this year, and it is expected that by the end of the season there will be 12 or 15 miles of Tarvia B surface treated gravel roads 18 ft. wide in Elgin Township.

By treating the gravel roads in this way it has been possible to carry heavy automobile traffic over the roads built of ordinary pit-run gravel, and to do this with but little inconvenience to the traffic, for the treatments give a hard, dustless, bituminous surface for traffic during the summer. This work in Elgin Township has been treated as a maintenance proposition, as it should be, and the gravel, after being treated, has been taken care of just as thoroughly as an ordinary, untreated gravel road. If the work is carefully done and the maintenance is properly carried out, it is possible to carry traffic up to 2,000 or 3,000 vehicles per day in a very satisfactory manner over these strengthened gravel roads.

Considerable credit is due Mr. Burnidge for the way in which he has solved the rather difficult road problem in Elgin Township.

DRAINAGE EXPERT DISCUSSES HIGHWAY AS COMPARED WITH AGRICULTURAL DRAINAGE

By Edgar A. Rossiter, Consulting Civil Engineer, 127 N. Dearborn St., Chicago.

As we read the articles by various highway engineers relative to drainage, the thought comes that perhaps a treatise on drainage, both surface and sub-surface, applicable to highway construction, would not be amiss.

When the subject first came to my notice I thought that the reason the highway engineer was averse to drainage was simply a question of the cost, and for that reason the writer "butted in" to aid them in convincing their superiors that drainage was necessary, but their various articles and speeches lead me to think that they have not availed themselves of the mountains of data pertaining to drainage, printed by many of the State Experimental Stations and the Federal Government, or they have been unable to assimilate the great fund of information given through these channels, and they are promulgating theories that are diametrically opposed to those that are published by the very States that employ them.

Every drainage expert is familiar with hydroscopic, capillary and gravitational forms of soil moisture and their characteristics under certain methods of drainage, and be knows further that he may so design his drainage system as to destroy the very object he seeks to attain. The expert drainage engineer, in designing a farm drainage system, plans his work and the depth of his tile in such a manner as to aid capillarity. If he wants a bone-dry drainage he places his tile deep enough to kill capillarity. In fact, there is more to drainage than just to design a conduit of proper capacity to carry off the surplus water. In defense of my position I shall quote from Bulletins of the Iowa and Kansas Experimental Stations, United States Geological Survey, "The Principles of Soil Management," by Lyon and Fippin, and other authorities.

Iowa Bulletin 50, page 7, says: "The underdrainage systems of Iowa are constructed primarily in agricultural lands to increase the potential production of those lands. The study of soils and soil mois-

ture and their relation to crop production is essentially agricultural, but the relation of these to drainage is a part of drainage engineering, and a knowledge of them is essential to the engineer employed in underdrainage work."

* * * * *

"The proper spacing and depth for lateral underdrains are dependent upon the amount of the surplus soil moisture and the rate of its movement through the soil. These, in turn, are dependent quite largely, in each locality, upon the character of the soil. The same principles which determine the proper spacing and depth for the lateral underdrains also determine the rate of run-off from these drains, and a correct understanding of these principles is dependent upon a general knowledge of soils and soil moisture."

* * * * *

"Each different soil area has its peculiar properties and each presents a different problem in drainage, due, primarily, to differences in topography and the physical or mechanical composition of the soil."

* * * * *

"The agriculturist, in considering the physical properties of the soil of any region, will divide his information into that relating to the top soil, or the seed-bed of cultivatable crops, and that relating to the subsoil. The drainage engineer may or may not divide the soil in this way, depending upon the thickness of the top layer of soil. If this surface layer is 4 or 5 ft. thick the lower stratum will have little effect upon the underdrainage unless its perviousness or imperviousness be extreme.

"The drainage engineer will look rather upon the soil as a whole, and base his conclusions upon its general physical properties, considering, of course, any unusual formations. In some cases he may need to consider more than two layers or strata. The drainage engineer should not ignore the study of the agricultural possibilities of the soil in any proposed drainage district, because upon this will usually depend the feasibility, from an economic standpoint, of the proposed work."

* * * * *

Soil Moisture

"In discussing soil moisture and its movement only such phases of the subject as have any special relation to underdrainage will be considered. The subject in its entirety is so complex that only an elementary treatment is either possible or desirable here."

Forms of Soil Moisture

"Soil moisture is of three different classes: 1. Gravitational water, or that which is free to move under the influence of gravity. 2. Capillary or film moisture, which is held, by surface tension, against the influence of gravity. 3. Hydroscopic moisture, or that which condenses from the atmosphere upon the surface of the soil particles."

* * * * *

Gravitational Moisture

"Land drainage has been aptly defined as the removal of the surplus moisture from the soil. Usually this is only the means to an end, as the benefits of drainage are due to those actions made possible by the removal of the surplus moisture. Underdrainage is the removal of this water by artificial or natural means under the surface. As it is only gravitational soil water which is free to move under the influence of gravity, and which is unavailable for and injurious to plant growth, the need for drainage is proportional to the amount of this form of moisture present in the soil."

* * * * *

Watertable

"The surface of the gravitational water in the soil, or the surface of the saturated layer, is commonly called the watertable. It is also referred to as the ground-water level, ground water in this sense meaning gravitational soil moisture, or surplus moisture."

* * * * *

Capillary Moisture

"Insofar as plant life is concerned, this is the most valuable form of soil moisture and, in fact, the only form which is available for the sustaining of plant growth. It is held against the force of gravity, in the small pore spaces between the soil grains and as a thin film surrounding each individual particle or group of particles. It is the surface tension which holds the capillary water in the soil."

* * * * *

Available Capillary Moisture

"However, not all of even the capillary moisture is available for plant use. A certain portion of it is held so intimately that the small roots cannot draw it from the soil. This fact is illustrated by the data in Table A, which is compiled with data given in Lyon and Fippin's 'The Principles of Soil Management.' The value in the column headed, 'Approximate per cent of Moisture of which Crops will Wilt,' are the amounts of water which are

TABLE A

Kind of soil	Dry porosity per cent	Approximate per cent of water crops will wilt	Available moisture depth inches in top 4 ft.
Dune sand	52.2	3.0	4.6
Coarse sand	51.0	3.0	5.2
Fine sandy loam	50.0	5.0	8.5
Silt loam	50.0	10.0	6.9
Clay	59.0	17.0	7.0
Muck soil	80.0*	80.0	20.5

*Assumed.

TABLE B

Per cents of Hygroscopic moisture at 21° or approximately 70°.

Very fine sand	1.8 per cent
Silt	7.3 per cent
Clay	16.5 per cent

held so intimately in the soil as to be unavailable for plant use."

Hygroscopic Moisture Content

"The amount of this form of moisture in a soil is a function of the surface area exposed and consequently is greater in the finer grained soils. The amount also varies inversely as the temperature in the soil. Table B shows the amounts of hygroscopic water held by three soils, each of which was a soil separate obtained by careful analysis.

* * * * *

Comparison of these data with others in the text from which these were taken show that all soils hold a considerably larger percentage of capillary water than of hygroscopic water. The importance of this form of moisture is further reduced by the facts that it is varying in amount and unavailable for plant use. It has practically no bearing at all upon the underdrainage of the soil.

* * * * *

Forms of Soilwater Movement

The previous discussion of the types of of soil water will readily suggest the forms of soil-water movements. Each of three forms of soil-water has a distinct type of movement:

1. Gravitational, or the movement of gravitation water under the influence of gravity.

2. Capillary or the movement of capillary moisture due to capillarity of surface tension.

3. Thermal or the movement due to changes in temperature. This latter movement is in the form of water vapor, though changes in temperature have some effect upon the other two types of movement.

* * * * *

Thermal Movements

This movement takes place as the movement of water vapor and consequently is relatively very small.

* * * * *

Evaporation

Evaporation of soil moisture may take place not only at the surface as is popularly supposed, but also in the deeper pores of the soil.

* * * * *

Capillary Moisture and Drainage

Capillary moisture has no direct relation to underdrainage though it has a very definite and important bearing upon the results and effects of drainage. When the plane of saturation is lowered by the use of underdrains the moisture necessary for crop production must be supplied by capillarity.

* * * * *

Capillary Movement

In the discussion of capillary soil moisture its importance to plant life and its relation to underdrainage were explained. Its movement naturally bears the same relation to these as the moisture itself. It is of vital importance to crop production but of very little importance to the operation of underdrainage.

* * * * *

Form of Movement and Factors Governerning It

The form in which capillary moisture occurs in the soil is a thin film of moisture surrounding the individual soil particles. Its movement then is a film movement and depends upon an unbalanced condition in the pull exerted upon these films. Any moisture which is moved in this way naturally moves as a film and consequently is small in amount. This movement always takes place from the wetter soil to the dryer regardless of the direction.

TABLE C Moisture Content of Soils

Kind of Soil	Weight per cubic foot, pounds	Pore space per cent	Maximum water capacity per cent	Maximum capillary capacity per cent	Maximum gravitation capacity depth inches in top 4 ft.	Maximum gravitation capacity (per cent)
Dune sand	80	52	40.5	10.7	18.3	29.8
Coarse sand	81	51	39.5	10.6	18.0	28.9
Fine sandy loam	83	50	38.0	18.0	12.7	20.0
Silt loam	83	50	38.0	20.9	12.1	18.9
Muck soil	15	80	333.0	250.0	9.6	83.0
Clay	68	59	54.5	30.4	7.3	13.9

The soil factors governing this movement are texture, structure and dampness. The finer the soil particles the more surface is exposed and consequently the greater capillary pull is exerted. In general it may be said that the extent of capillary movement is inversely proportional to the fineness of the soil grains. It is also true that when the soil grains are very fine the spaces between them become so very minute and the thickness of the film of moisture so reduced as to increase the friction and make the movement very slow. It is also necessary for water to wet any substance to which it is held by capillarity, hence if the soil particles are somewhat dry the moisture is not held to them strongly until they become damp, as all natural field soils have a certain resistance to wetting. The rate and extent of this movement are also affected to some degree, by the temperature changes. The surface tension is greater for low temperatures than for high, causing both a greater rate and a greater extent of movement at the lower temperatures. On the other hand, warm water is more limpid than cold and will consequently pass through the small pore spaces more readily.

* * * * *

Relation of Capillary Movement to Underdrainage

The most important phase of this movement in relation to underdrainage is the distance which a sufficient quantity of water for crop production will be raised. It is the effect of any drainage to lower the permanent water table after which the moisture for sustaining plant life must be furnished capillarity. If the water table is held at too low a stage an insufficient amount of moisture will be raised to the upper soil layers and the crops may suffer. In such a case the underdrainage system will have been too effective and its results will be no better than those conditions which obtained before any drainage was attempted.

* * * * *

Rate and Extent of Capillary Movement

As has been stated the rate and extent of capillary movement depend upon the distance the water is raised and the nature of the soil through which the movement takes place. In part two of the Nineteenth Annual Report of the United States Geological Survey, is given experimental data from which Table E was compiled. These data illustrate the principle that the rate of movements varies inversely with the extent and distance of the movement. The lower rate of movement in the clay soil from each lift is probably due to the greater friction and greater resistance to movement in the finer grained soil.

* * * * *

The report referred to indicated that for natural field soils the movement is fairly rapid when the lift does not exceed 4 ft.

* * * * *

Capillary Movement and Depth of Underdrains

From the standpoint of the supply of capillary moisture the above data indicate that the ideal underdrainage system for the average Iowa soil which is to be used for the ordinary field crops is one which will maintain the groundwater level at a depth of from 2.5 to 3 ft. below the average elevation of the crop roots. However, this depth varies slightly for the various crops and soils. The depth seems to afford the maximum storage capacity without so lowering the watertable as to reduce the capillary movement too greatly. There are, however, other factors than the supply of capillary moisture which must be considered in determining the depth of underdrains.

The gravitational movement is the result of the gravity pull upon the soil water, and, as both the capillary and the hygroscopic moisture are held against gravity, it is only the gravitational soil moisture which is affected. This moisture and its movement are usually referred to as "groundwater" and groundwater movement or "percolation."

* * * * *

Effect of Soil Texture

The influence of the texture of a soil upon the movement of groundwater is due to the variation in the size of the soil pores resulting from differences in the sizes of soil grains. The finer the soil grains are the smaller the pore spaces and, consequently, the higher the resist-

TABLE D

Gravitational water capacities of soils near Hanford, Cerro Gordo County, Iowa.

Kind of Soil	Depth of sample below surface	Gravitational water capacity per cent
Black top soil.....	3 ins.	18.5
Clay, a little sand..	2.5 ft.	8.5
Whitish yellow clay	3.5 ft.	2.5
Blue clay	4.5 ft.	6.6
Sandy clay	3.0 ft.	13.9
Sandy clay	4.0 ft.	18.6

TABLE E

Pounds of water per day per square foot of soil raised from different depth.

Soil	1 ft.	2 ft.	3 ft.	4 ft.
Medium fine sand.	2.37	2.07	1.23	0.91
Medium clay loam	2.05	1.62	1.00	0.90

ance which they offer to the passage of percolating water. The rate of percolation varies directly as the size of the soil grains until in some very fine grained soils the pores become so small as to be completely filled with capillary moisture.

* * * * *

The Viscosity of the Moving Water

The effect of temperature upon the movement of gravitational water is of considerable importance. The viscosity of water decreases as the temperature rises, and consequently, the flow increases with the temperature of the water. Hazen found in his experiments with filter sands that the relative flow at different temperatures varied from .70 at 32 deg. to 1.0 at 50 deg. and 1.45 at 77 deg.

* * * * *

It has become quite general practice to design underdrainage systems in which the laterals are placed 4 ft. deep and 100 ft. apart.

In close soils or in average soils to be used for truck crops this spacing should be decreased to 75, 50 or even 33 ft. as the conditions demand.

When moisture is to be supplied by capillarity, as is the case during periods between rains, the lift should not exceed 2.5 to 3 ft. if the crop is to be fully supplied.

From an agricultural standpoint the proper depth of tile in sand is 2.5 to 3 ft., the capillary capacity being 10 per cent, 1 8 10 per cent is hygroscopic moisture.

In clay the depth of tile should not exceed 4 ft. deep, the maximum capillary capacity being 30 4/10 per cent of this, the hygroscopic water is 16 5/10 per cent, leaving 13 9/10 per cent of available moisture. Therefore in ordinary soils there is a limit to the capillary force or suction and when you exceed that limit, capillary flow ceases, the depth at which the force ceases varies in the different soils. In highway drainage the scheme is to lower the surface of the ground water to a point where the water table between two drains is below the capillary suction.

To obtain the best capillary results in clay soils the tile should be placed 33 to 36 ft. apart and not to exceed 3.5 ft. to 4 ft. deep, and I will venture to state that in 99 per cent of tests, made by highway engineers, the tile have been so placed and then the engineer rushes into print telling of the failure of drainage in highway construction and even to the fact that "there was less than 6 per cent difference in moisture content in drained and undrained roadways." "therefore drainage was a fallure." Let us see where the water table of his groundwater was under these conditions, which are Ideal from the agriculturalist view, and we will turn to page 38 of our Iowa Bulletin Number 50, and to the 1912 issue of Kansas Land Drainage, by H. B. Walker. (Figure 1.)

A and C are two tiles 4 ft. deep in clay soil, spaced 36 ft. centers. D is the groundwater or water table during wet season. E is the water table at the dry season. D is 11 ins., and E is 2 ft. 5 ins. below the surface of the ground (ideal conditions for the farmer), but these same tile might just as well be hung on the telephone poles for all the good they do the high-

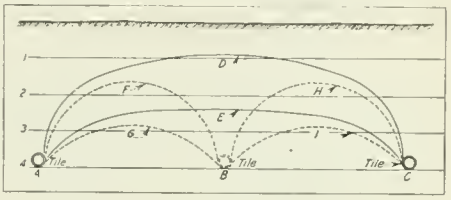


FIG. 1.

way because the peak of the groundwater is under the center of the roadway, and during the winter the frosts would heave the pavement and during the spring floods the pavement would be floating on a sea of mud.

Suppose we placed a tile at B then the water table would be lowered to F and H at flood time and G and I in dry weather, let us then lower the tiles A, B, and C until G and I would be 4 ft. below the surface. A, B, C are 18 ft. apart, capillary action ceases to be as strong and if under a pavement with subgrade properly rolled, capillary suction sealed off, by reason of the sub-soil being rolled to imperviousness, you then can obtain a bone dry subgrade, the opinion of several writers to the contrary notwithstanding.

There seems to be a peculiar understanding among engineers, both drainage and highway, as to the full effect of a well-designed drainage system as to spring conditions of highways, as well as field drainage. The Westmoreland Drainage District, comprising some 2,500 acres of extremely flat lands, has a 2 ft. top soil of black sandy loam, 6 ft. layer of sandy clay to hard-pan. The outlet tile runs through a 15 ft. ridge of hard-pan into the river. This outlet tile is placed in the road ditch for about one mile, there have been no chuck holes or heaving in the roads since the tiles were placed, water runs in the tile at the outlet 2 and 3

ins. deep in mid-winter at 22 degs. below zero.

Every foot of this drainage district is dry and the frost goes to 5 ft. depth in winter. The first spring rain and often the January rains melt the top crust of damp frozen soil and the water passes down through the drained soil and not over the top as some engineers would insist that it should, or in other words the capillary and hygroscopic water when frozen do not close all the pores in a well-drained soil.

In view of the fact that some of our highway engineers have publicly stated that tile drainage is of no value and that open ditches are better, I wish to state

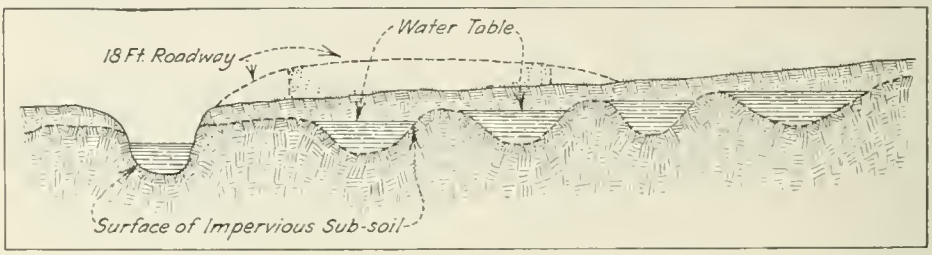


FIG. 2.

that an open ditch is only good when cleaned out, is free from weeds and other impediments and then only during the summer months. During the fall and winter the dead leaves, ice and snow form barriers and in the early spring when most needed is in no shape to free itself much less the adjacent lands. A shallow ditch will drain the surface only, a deep ditch is a menace to life and property and rarely is in good condition over ten months of the year.

Let us see what Kansas has to say about open ditches, Fig. 2 is a copy from its 1912 Bulletin, page 43.

"Impervious soils retard the free percolation of water by gravity and also prevent lateral movement of soil moisture."

Fig. 2, shows an average section of soil. This is a good example of what the highway engineer meets in every day construction. We will assume that the ditch is 4 ft. wide and 3 ft. deep and scale an 18 ft. roadway thereon. It is quite evident that unless some method is used to cut through the impervious sub-soils that the pavement is going to be laid in a sea of mud, and though the engineer put a ditch on both sides of his road and roll his sub-grade, he still will have his water pockets to heave his roadway during the winter. It must be remembered that ditches are for surface drainage and except in sand and light soils the water table is the surface of the ground. I have dug deep ditches within 10 ft. of a pond and not lowered the level of the water a quarter of an inch.

There has been much said and printed relative to rolling the sub-grade. I believe a sincere study of soil structure might change the ideas of a vast extent of those who state certain presumptive ideas of their own as facts and wind up with the sad theory that "no solution is obvious." In my limited railroad experience the excuse railroad engineers give for construction of roadbeds 4 or 5 ft. above the surrounding terrain was to get above capillary flow and to obtain a reasonably dry sub-grade to ballast the tracks, and if such is not obtained the ballast will roll and disappear into the sub-grade.

I would be pleased to go into the details of rolling sub-grade at some later date at which time I may also explain the value of hydroscopic water and its use in making soils impervious. As early as 1908 I prevailed upon a tile company to manufacture an extra heavy shale tile to be known and used as Road Tile. There is a difference in tile and Iowa has made some interesting tests of tile. The University of Illinois has published a number of reports relative to concrete and every engineer should read them before making doubtful statements.

TAR SURFACE TREATMENT OF GRAVEL ROADS IN MAINE

By Paul D. Sargent, Chief Engineer, State Highway Commission, Augusta, Maine

For the last eight years the Maine State Highway Commission has been surface treating gravel roads with success. During that time we have used exclusively a refined tar product suitable for cold application.

I believe it may be of interest to relate

some of the experiences from which our standard practice in the surface treatment of gravel roads with bituminous material has been developed.

Early Experiences

Some eight or nine years ago when we first tried these treatments the principal use of surface applications was for the purpose of allaying dust. Light asphaltic oil, known as "45 percent oil," was generally used for that purpose. The real effect of the oil always appeared to me to be merely to load the dusty surface particles of the road with so much weight that when stirred up by passing traffic these particles did not rise very much above the road surface and consequently were blown and moved around much. Naturally, we more or less followed in our early tar applications methods in vogue at that time. We attempted to get a true crown on our gravel roads by adding 1 in. or 1½ in. of new gravel where necessary and then by the use of a drag or light grader truing up the surface before the application of the bituminous material. The first year this work was done on any scale we applied our bituminous material in two applications. In May we used about 0.4 gal. to the square yard and about the first of August retreated all of these surfaces with an additional 0.2 gal. per square yard. Treatment was laid only 10 ft. wide. The real thing we sought to do with this treatment was to bond the loose surface material to the tightly bonded surface below it, and we fairly well accomplished this result.

By the end of the season, however, we observed that on certain sections of our roads so treated there was a slight rippling and waving of the surface. It occurred to us that this might be on account of the fact that we had not secured an effective bond between the loose surface particles of the road and the tightly bonded gravel beneath. In other words, the material which had been impregnated with tar had laid more or less as a mat upon the surface and, not being sufficiently filled with mineral aggregate, had pushed.

We had obtained, however, a much more satisfactory surface, generally speaking, than we had ever before seen on any surface treated road. The good sections presented the appearance of a first-class bituminous macadam surface, tightly sealed, smooth and dustless. As might have been expected, the edges of the bituminous treated section sheered off and crumbled away on account of so much traffic turning out for meeting and passing.

Cleaning Gravel Before Applying Tar

Our next development was an attempt to clean the gravel surfaces before the application of the tar. This was accomplished by the use of graders and drags and later by using a street sweeper and finally by following that with hand sweeping. We also increased the width of our treatments to 15 ft. We found that all of these steps gave us a much improved surface, and, in fact, since the first year we have used tar we have never made but one application to any gravel surface during a season. No sand covering was used during our first two or three years of treatment. The tar was applied on warm dry days from an automobile tank distributor under pressure and we just allowed the tar to lie on the road until it was absorbed and took its set.

Treating One Side of Road at a Time

Needless to say, we had much complaint from the traveling public on account of the dangerous condition of a freshly tarred surface for rubber-tired traffic. We attempted to obviate this danger as far as possible by treating one side of the road at a time. We would do a considerable stretch of road, anywhere from 6 to 10 miles long, and treat it on one side only. While the treatment was being put on the first side the other half of the road was left open for traffic and by the time we had the first half finished the tar that had been first laid was well enough set so that traffic could go on it. Then the other half of the road would be treated in the same way.

We observed, of course, that steel-tired traffic, wherever it ran on the freshly tarred surface, stripped the bituminous material from the surface. This made it necessary to do more or less patching by hand. Also, on account of the increasing automobile traffic, which was continually getting on to the freshly tarred surface, we found it necessary to sand the tarred surface a few hours after application.

Immediate Sanding

For the last three or four years we have made a practice of treating all of our surfaces 18 ft. in width, which has practically obviated the necessity of any patching on the shoulders or edges of the treated surface. Eighteen feet in width, which, by the way, is our standard width of pavements and hard surfaces today, affords a good double track way. We have been following the practice during the last three or four years of immediately covering the bituminous

material with a light application of sand. By immediately, I mean that within 5 to 10 minutes after the distributor has delivered tar to the surface of the road is has been covered with sand.

Proccdure in Sanding

There are one or two points about sanding that I think should be spoken of. We place the sanding gang at intervals of 150 to 200 ft. apart, according to the length of road that the tank of tar will cover. Immediately the tar tank has passed, these men begin to sand, and the sanding is started at the center of the road and first a place is made where passing vehicles may turn out on the freshly tarred surface. This affords traffic meeting places at stated intervals, so that with careful driving it is not necessary for a vehicle to become smeared or spattered with tar or to take the risk of skidding incident to driving on a freshly tarred surface. Our sanders are also instructed to keep an eye to the traffic so in case anyone gets into difficulty we will have some witness as to what actually happened. These men also more or less caution drivers to be careful. Where we are applying tar over a summit grade we always plan to have a sander stationed at the summit to keep an eye to passing vehicles and to warn them against collision. These are points we have learned from experience and we have found them to pay. I offer the suggestions for what they are worth.

Maine Standard Practice

I might say that in general we have developed the following standard practice: As early as we can get on the roads in the spring, that is, when the roads begin to settle and dry out after the frost has left them, we begin shaping with the road grader. The roads are carefully watched during the two or three weeks while they are settling and are shaped either with a drag or blade grader several times if necessary to have them settle with as true a contour as possible.

The next step in our surface treatment is to draw out sand, which is left on the shoulder of the road in piles of about a quarter of a yard every 25 ft. Generally speaking, we use about 50 yds. of sand to a mile for cover. We use less sand, however, on a brand-new treatment than we do on re-treatment. Sometimes as little as 30 yds. to a mile is used on the original treatment. Re-treatments will take from 40 to 50 yds. per mile, as the tar has less opportunity to penetrate into the surface of the road.

The next step is to clean the surface of the road of all loose material. If a pocket of sand, dust or stone is left on the surface we are absolutely sure to have the treatment break over that pocket in a short time after application. This cleaning is done by the use of a street sweeper behind a light truck and if further cleaning is necessary after the sweeper has finished this is done by men with push-brooms.

Then comes the tar distributing gang, which is equipped with Kinney pressure distributors mounted on 3½-ton trucks. We have limited ourselves to this size of equipment because it is as heavy as our roads, generally speaking, will carry. We have a law which limits the gross weight of load to 9 tons, and I am free to say that one of these 600-gal. tanks filled with bituminous material will a little exceed the limit set up by statute for the gross weight of load. Under average conditions one tank truck will spread about 2,500 gals. of tar per day.

We still hold to the practice of tarring one side of the road at a time, and several days may elapse between the tarring of the first side and the tarring of the remainder of the road. As previously pointed out, immediately after the tar is applied a light sanding is given. We put on just enough sand fairly to blot the bituminous material and keep it from running off the crown of the road to the edge.

The surface is carefully watched for three or four days and if evidence of bleeding shows up, spots where this occurs are treated with more sand. Sometimes after a treatment has been down for two or three weeks an extremely hot day will start a little bleeding. This is watched carefully by the patrolmen and the same treatment of light sanding given.

In the treatment of new gravel surfaces, that is, surfaces which have never received a treatment before but which may have taken traffic anywhere from two to four or five years with an occasional resurfacing of gravel, we use not to exceed ½ gal. per yd., and in more cases probably use 0.4 to 0.45 gal. per sq. yd. for the treatment. The amount of material depends upon the tightness of the surface. We have found that the smallest quantity of material we can use and get the surface covered gives us the best result. With a small quantity we never have trouble from rippling or waving of the surface, provided the gravel is in proper shape to receive the treatment when it is given, that is, thoroughly bonded and tight, with no pockets of loose

gravel, dust or other material. We also find that surfaces which have received a small quantity of tar can be re-treated for a longer time than surfaces which have been given a heavier treatment. Those which have received the heavier treatments will ripple and get out of shape, say in two or three or four years, while sections receiving a light treatment can be maintained without breaking up for a considerably longer time.

It must be borne in mind that the addition of the bituminous surface treatment to a gravel road does nothing but preserve the surface against disintegration from passing traffic. It does not materially strengthen the road in the sense that is will cause the road to carry heavier loads than the gravel surface itself or the foundation upon which it is laid will sustain. Surface treatment will not supply or take the place of drainage.

Patrol Maintenance of Treated Sections

Our surface treated sections are kept under constant patrol maintenance. We patrol these roads with a light truck and two men and they are assigned sections anywhere from 12 to 18 miles long. Besides watching the bituminous surface and mending any small breaks that may occur—and we have these breaks occasionally—and patching the shoulders, these men also keep the dirt shoulders shaped by dragging, keep the gutters and culverts clear, and do whatever other work is necessary.

We supply about three barrels of bituminous material like that with which the road is treated for each mile of surface. This material is mixed with sand and kept in stock piles. The mixing is usually done by hand and we use about 17 gals. of tar to a cubic yard of sand. In a few instances we have used a small concrete mixer to prepare the tar and sand for patching and we have been able to use as little as 14 gals. to a yard of sand when the mixing is done in a concrete mixer. Patches are made by simply cleaning out the hole, throwing in the mixture of bituminous material and sand and patting it in with a shovel. Any bad breaks on the shoulders are repaired the same way.

The Spring Period

The most of our gravel treated surfaces do not remain intact over the spring period; a good deal of it breaks up. This is due to several causes. An open winter which allows the frost to penetrate deeply into the roadbed and allows traffic to run all winter long, or heavy traffic coming on these surfaces when the frost is leaving and the surfaces are soft will break up and generally disintegrate the surfaces. This really is more or less of an advantage, because it obviates the necessity of breaking up these surfaces and we save just that much expense in getting the surface ready for subsequent treatments.

I have in mind one section of gravel road which was surface treated during the summer of 1920. Most everyone called it a good section of road, in fact many automobilists have referred to it as bituminous macadam, and many of our citizens refer to our surface-treated gravel roads as bituminous macadam roads, especially when they want to tell about a bituminous road the Highway Commission has built which has failed in the winter. The particular section I refer to was so bad during March, 1921, that automobiles could not pass over it, or through it. For four or five miles this piece of road was literally a sea of mud for a period of about three weeks. Of course the surface treatment completely disappeared. We reshaped the road as it dried out and retreated it last spring. It presented a good surface all through the summer and fall until it was covered with snow.

On the other hand, I have in mind one section of surface treated gravel road which is built on a sandy foundation, where the drainage is perfect, that has never broken up during the last eight years. It gets a re-treatment about every other year, maybe 1/6 or 1/7 gal., as the gang goes by, and during the intervening year it does not get treated. This particular section shows evidences of slight ripples. It is on our heaviest traveled line, where the snow leaves earliest in the spring and we have the most severe truck traffic in the State.

We have a good many sections of surface treated gravel roads which do not break up in the spring. The most of these sections get a re-treatment each year. The second year the amount of tar which we have used has been from 3/10 to 1/3 gal. per sq. yd. For the third and fourth years the amount has run as light as ¼ gal., and in some instances 2/10. These surfaces are quite likely, however, after three or four re-treatments, to become ripply enough so as to be uncomfortable to ride over. This condition is due to a combination of reasons. One is that we may have as much as 1½ or 2 ins. of tar penetration which becomes separated from the gravel road itself on account of the passage of heavy loads when the frost is coming out of the roads

and the whole roadbed is more or less soft. Where this tendency exists at all it is always more pronounced where the surface has received successive treatments than where only one or two treatments have been given.

Each year we have to break up more or less of this kind of surface and get the road in shape for new treatment. The method used is about as follows: We take a section of road about 1,000 ft. long; it is broken up either by using a pressure scarifier or a steam roller or by using a heavy blade grader behind a truck or a roller and setting the blade so that it will do more of a plowing operation than a scraping one. The bituminous surface is in this way broken up into chunks anywhere from 2 ins. to 2 or 3 ft. square. We next take a road grader and scrape this whole surface off to the shoulder of the road, then we plane the roadbed below to as true a surface longitudinally and transversely as possible. We then work back a portion of the bituminous bound material from the shoulder, distributing it over the surface. In this distributing operation the bituminous bound gravel is broken up more or less into small chunks. We then leave the road for two or three days for traffic, which materially helps in further breaking up these pieces of bituminous bound gravel, then the road grader is brought on and further working of the surface is given just by pushing the chunks around and pulling in more from the sides. By watching the surface carefully and using the road grader every two or three days we have been able to get the surface back into reasonably smooth condition. It presents more or less of a mottled or mosaic appearance.

Gravel which has been covered with the bituminous material has lost its binding property and it is necessary quite often to add a bit of good binding material here and there to complete the bonding of the surface. This binding material is used sparingly. We do not intend to have enough to leave any appreciable amount of dust to be swept off prior to the new treatment. As soon as we have the surface in shape we plan immediately to give it a new application of tar. We find that one of these surfaces broken up and reshaped as just described is very hard to keep in true contour under traffic and if it is allowed to go, say, two weeks, we may have to break it up and rebond it before the tar surface treatment is given, else it would be so uneven as to be a bad riding road all through the season.

Experience has shown that one of these old tar surfaces can be scarified and broken up much more easily when the temperature is between 60 and 70 degs. F. than during cooler weather. Good warm, sunny weather also materially assists in breaking up the chunks of tarred gravel which are left on the surface of the road.

Gravel Surface Must Be Dry

One thing we have satisfied ourselves upon is the fact that we cannot successfully apply tar surface treatment on a wet road or on a damp road. We have also had the experience of rain falling within two or three hours after tar has been applied and before the tar has taken any set, and with a traffic, say, of 100 to 200 cars per hour this has resulted in making a mushy surface which it is practically impossible to true up and make satisfactory. We have practically come to the conclusion that when this condition prevails we would do better to scrape the new tar surface right off on the shoulder, throw it away, reshape our road and put on a new application of tar. We will spend more money in patching the surface which is laid under these conditions than it would cost to replace the surface, and such surface after patching has never been satisfactory.

Costs

During the last four years our surface treatment work, plus the cost of patrol maintenance, for a season of eight months has averaged to cost $1,000 per mile. We estimate sand to cost us an average of $2 per cu. yd. delivered in piles alongside the road. Tar costs us $0.12 in tank cars delivered on the nearest railroad siding. We figure the cost of applying the tar at $0.02 per gallon. Sanding costs about $0.75 per cu. yd. of sand. Using, say, 4,000 gals. of tar per mile gives us a cost for tar on the roadbed of $560; 50 yds. of sand will cost $100, applying the same $37.50, making the cost of the tar treatment covered with sand $697.50.

The average cost of shaping and getting the surface ready for treatment in the early spring would be about $25 per mile. We use ordinarily a 2-ton truck to draw the road machine. The truck rental would be $10 per day, the driver's pay $3.75 and a helper $3. The rental of the road grader is figured at $2 per day. Gas and oil will run from $5 to $6 a day. This outfit will average to smooth four miles per day. Usually on the first smoothing we make about four round trips per mile. On subsequent smoothings possibly two trips will do; it all depends upon the condition of the road when it

is smoothed and the subsequent condition of rain and settling of the road.

Sweeping

For sweeping we use a mechanical sweeper drawn by a light truck, say a ¾-ton or a 1-ton truck. We usually make four round trips with the sweper, and this outfit will sweep about two miles per day, as we can only run the sweeper about three miles per hour. The expense for sweeping would run about as follows:

Truck rental	$ 5.00
Oil and gas	2.00
Driver	3.75
Helper	3.00
Rental of sweeper	2.00
Making a total of	$15.75

An expense of sweeping two miles of $7.87 per mile.

An expense of sweeping two miles of $7.87 per mile.

The balance of the $1,000 is paid for patrolling the road through the season. The usual patrol gang on bituminous surface treated gravel roads is a patrolman with a 1-ton truck and helper. According to the amount of traffic and the condition of the road, this outfit will cover anywhere from 12 to 18 miles of road. The outfit costs $13.75 per day, made up as follows:

Rental of 1-ton truck	$5.00
Gas and oil	2.00
Patrolman, who drives the truck	3.75
Helper	3.00

These gangs work an average of 200 days per year, so if the patrol section was 13¾ miles long the average cost per mile would be just $200.

Based on the figures given above, this would show a maintenance cost of $930.37 per mile. I have said that on new roads we use ½ gal. of tar per sq. yd. That will increase the cost $140 per mile over the figures already given.

Where it is necessary to scarify or break up the old bituminous surface, we run into a considerably larger expense for preparing the surface than indicated above. I think I have given enough explanation, however, to show that the average cost is very close to $1,000 per mile.

There is one point that I neglected to mention, and that is that quite often in making an original treatment if traffic is running fairly heavy and it will take us six or eight days to treat the section we are working upon, we will slide over the road with a priming coat of the tar material, using 2/10 to 1/4 of a gal. per sq. yd., the quantity depending upon the tightness of the surface. This will hold our surface in perfect condition under traffic for a week or ten days. We immediately apply the balance of the quantity, sand, and finish up the job. We have almost come to the conclusion that it would be good practice to do the priming everywhere on new surfaces. It gives a better penetration of the bituminous material, besides holding the surface in proper contour until the treatment can be completed.

I ought to state before closing that we have many miles of surface treated gravel roads which are carrying a 12-hour traffic, from 7 a. m. to 7 p. m., averaging from 2,300 to 3,500 vehicles per day for a week's time, with a maximum traffic durtng the 12-hour period of as high as 5,500. This traffic continues for a period of four to five months, from about the twentieth of May until well toward the first of October.

We find it impossible to hold our gravel surfaces in satisfactory condition by ordtnary patrol maintenance methods, that is, dragging and patching with gravel, when the traffic exceeds 500 to 600 vehicles per 12-hour day, and the expense of such maintenance runs about $500 per mile.

The material which we use for surface treatment falls within the specification T. C.-1, Tar for cold application, Bulletin No. 691, U. S. Department of Agriculture.

Credit for the most of the developments we have made in surface treatment of gravel roads is due to Mr. A. J. Wiggin, Superintendent of Maintenance of the Maine State Highway Department.

The foregoing matter is from a paper by Mr. Sargent before the recent conference of highway engineers at the University of Michigan, Ann Arbor, Mich.

HIGHWAY MAINTENANCE IN BUREAU COUNTY, ILLINOIS

By C. L. Melcher, County Superintendent of Highways of Bureau County, Court House, Princeton, Ill.

Bureau County is one of the rather large size counties in Northern Illinois, having an area of 881 square miles and a total road system of 1,482.2 miles, with 296 miles of State Aid System. The county has considerable variety as to soil and topography, there being almost any condition in Bureau County that will be met in the State of Illinois. We have some very hilly country that is mostly clay, with some timber covering, and we have the typically rolling prairie and there is also some swamp land, hardpan and blow sand. These conditions are met with on the State Aid and Bond Issue Systems in Bureau County and some of them are difficult to overcome. Probably the heaviest

earth work section on the Chicago-Springfield road is in Bureau County between Spring Valley and Depue. Grades of 7 percent were found necessary by the Division of Highways to overcome the heavy hills in that section .

Previous to Jan. 1, 1921, the county had done the usual amount of grading as done by the several townships, had met the allotments of the State in the construction of about 9½ miles of concrete and brick pavement on the State Aid System and had advanced funds for the construction of a 15d section on the Chicago-Springfield road. No plan for maintenance of earth or gravel roads or the improvement of the State Aid System had ever been presented to the people of the county nor had any such maintenance been done by the county.

In the summer of 1920 we conceived the idea of maintaining and reconstructing the State Aid System outside of the Bond Issue System in Bureau County and for the purpose of carrying on this work for four years, the Board of Supervisors passed resolutions asking for a special tax for this work under authority of Section 27 of the County's Act of the Illinois Statutes. The rate of tax for this work was placed at 60 cts. on each $100 of assessed valuation and was presented for a period of four years with the idea that at the end of that term conditions would be somewhat different and construction and maintenance plans would then be revised for carrying on further work. This tax was calculated to yield about $215,000 per year, or a total of $860,000 in four years.

It was not expected, at that time, to do any extensive improvement on the sections of the State Aid System that were already well surfaced with gravel, but to give speedy relief and improvement on the worst sections by grading, draining and gravelling. The tax was voted with a majority of about 3 to 2 and the Board of Supervisors levied the tax and began to plan for the first year's work.

Changes in the State Aid System

At the same time that the plan was presented for the maintenance and improvement of the State Aid System of the County, a resolution was presented providing for a revision of the State Aid System in order to give a better engineering location and as a consequence better connections between the several towns and communities of the county, especially with the Bond Issue System. The routes were made in such a way as to give the several townships that were not fortunate enough to be on the Bond Issue System a direct and quick connection to that system and also to connect consolidated schools, country churches and community centers.

A county system of highways is a secondary system of roads and should be located and improved in such a way and in such order that the so-called through routes may be of greater service to each county and community. An analogy could be drawn between the Bond Issue System and the State Aid System of the several counties and a double-track main line railroad and its branches. We cannot all live on the double-track line, so we must have branches or feeders to these main lines that are of real service, or, in other words, will handle the local traffic for 365 days of each year. We will then begin to have real "farm-to-market" roads and our highway system will realiy begin to function. People living in townships off the Bond Issue System are going to demand that kind of service.

Bureau County Road Problems Similar to Those of a Greoter Part of the Counties of Illinois

We began our work in March of last year by first establishing a patrol system of maintenance on the entire county system. Men were selected who seemed to be able to work by themselves without too much close attention or check on the time they put in on the work. These men were not teamsters but a great many of them were men who had farmed and knew road conditions where they were employed. They have given us, as a whole, very good service and most of them will be employed in 1922. Their experience and training is worth money to us. We employed 27 men on 230 miles of road with the sections having a mileage of from 7 to 11 miles. We have found that the proper size section is about 7½ or 8 miles where there is a fair amount of traffic. On an earth road a patrolman will get behind in maintaining his section when we have a succession of showers at one or two days interval. This is true even in weather when the roads dry very quickly on the morning following the shower. Some patrolmen like to tackle the worst mile first and give that a thorough smoothing before taking the rest. But that system is not correct. They should on an ordinary width of roadway, travel over the entire length of the section on one track and return the same day by widening that track. This will give within a few hours, one smooth path for traffic. The next day

they can cover the other side of the roadway and will probably need an additional day to shape up spots that have dried later or that were badly cut up. An earth road is a wonderful road when it is smooth and the patrol method of maintenance is about the only way you can keep an earth road smooth. The continual working of the surface seems to case-harden the top and it becomes very durable. The ordinary rains and the milder seasons of the year do not affect it greatly if it is properly graded. We have found that our earth roads that were patrolled were fit for use during the summer season a couple of hours after a rain. Even the graded sections seem to shed the water very easily because there was no place for any water to stop and soak up the surface or damage the subgrade. However, an earth road will not stand such a prolonged wet spell as we had last fall. They will simply become so thoroughly saturated that they are of little use.

The patrol system of maintenance is the only reasonable way of keeping a gravel surface in condition for travel. Our old gravel roads when we took them over were very rough and full of holes and stones. We scarified those roads at a cost of from $30 to $50 a mile and the patrolmen raked off the stones and worked the loose gravel into the proper shape. The worst kind of a gravel road can be very effectively cured in this way and put in such condition that there seems to be a new surface. Where gravel is thin, it should have additional material put on at that time. The scarifying should be done to the depth of the deepest hole and all material should be torn loose with a scarifier and then thoroughly worked over with a blade grader. Where old gravel has had surface treatment such as oil, tar or bituminous material, the working with a blade after scarifying will break up the lumps and the road can be reshaped easily. However, after the big blade has done this work a patrolman should finish the job. The continual moving of the materials on top with a patrol grader as traffic in breaking up a portion of that old crust, serves to put the surface in a wonderfully smooth condition. The grader puts the real finish on that job. You will have to remove some teeth from the scarifier in an old oiled gravel road because it is very tough and very hard to break up. The tractor and scarifier have work up to their capacity. To maintain a gravel road properly you need loose material on the top that is moved back and forth with the patrol grader. In other words, the surface cannot be kept smooth until it is, as we say, alive. A gravel surface that packs and leaves no loose material is very hard to patrol because the only way to fill the holes or depressions is to cut loose some of the packed material or scarify the surface. After a rain the material that seems to have been rather sandy or lacking in binder will bind with the old material and form a fresh surface for travel.

We found further, that the two-horse, four-wheeled grader with the 6-ft. blade is the best machine or tool for patrol maintenance. However, there is considerable work on most sections of road that should be done by hand. The patrolman cannot make a good road with just a patrol grader. He will have to exercise some of his muscle. On hilly sections of road the ditches are either cutting or filling and they must be maintained and the water kept from flowing down or across the roadway or from undermining the shoulders. In cuts or on side hills the earth is continually moving into the ditches from the banks and the patrolman must care for his shoulders and clean the ditches before they become clogged or the water damages the roadway. In the heavier maintenance a large blade grader can clean those ditches very cheaply and effectually and also straighten or deepen the outlets.

The quickest way to get any road in a useable condition is to establish a patrol system of maintenance. A patrolman can simply work wonders with almost any road. At the beginning of our work we found that everybody wanted service of the large blade graders but this demand was lessened when a patrolman had been on the work three weeks or a month. In addition to the patrol grader, we furnished our men common slip scrapers and they furnished their own small tools.

Betterment of the County System by the Use of Ordinary Methods

Without doubt, the tool or machine most misused in highway work is the blade grader. The newer type of blade graders are a real road-building machine when you have properly trained operators. Bureau County purchased four tractors and four 12-ft. graders to begin the work of bettering the county road system. Two scarifier attachments were bought for these graders and our most economical and efficient work was done with these machines. The right of way on our roads in Bureau County averages from 50 to 66 ft. in width. With the old style of grading there seemed to be too much right

of way and a great many of the farmers began to move their fences in the road. On some roads there was considerable brush, stumps, trees and telephone poles on the road side of the ditch line. Where we encountered brush, stumps and trees, we used dynamite and the tractor to remove them and then cut our ditches straight through. We have staked our ditch lines at 40 ft. center to center by setting lathe on what might be called permanent ditch lines. The center line was carefully placed as possible with relation to fences and the present right of way as it would be placed for paved road. Then the ditch stakes were set with a transit 20 ft. each side of the center line, making a clear road way after construction with the blade grader of about 30 ft. We graded on county work approximately 70 miles of road and 20 miles on township roads. This was in addition to the scarifying of 70 miles and other maintenance of approximately 40 miles of road. Where the approaches to bridges and culverts were narrow and there were short hills to cut off or bad holes to fill in straightening the alignment, we employed teams to remove the earth longitudinally. The blade then cut the ditches and balanced up the earth work on the entire roadway. Our ditches are from 24 to 36 ins. deep, with occasionally a somewhat greater depth where we wished to raise the grade or have more waterway in the ditch. Some of these old roads were lower than the adjoining fields and that meant moving from 2,000 to 3,000 yds. of earth to the mile with the blade grader. Our road sections were built to give us approximately 6 ins. of crown on the 30-ft. roadway with the 1½ to 1 slope on both sides of the ditch and about 15 ins. width on the bottom of the ditch. This was modified where we worked in sandy sections or on hillsides. We have one piece of swamp land or slough that they said we could not grade. It was below the level of the fields and the soil was yellow and blue clay and just plain mud. We graded that in July and the clay brought up from the ditches has made an almost impervious surface. It seems to bear the weight of traffic better than any other section of road we have and it is cut up less after heavy rains. Our theory is that we have simply brought up material that formed a waterproof coat on the top of the old soil. Similar conditions have been observed in other places where hard pan or muck was uncovered in the ditches and we have found that the mixture of this material with ordinary top soil forms a first-class surface. It is better than either material would be alone.

The 12-ft. blade grader will build a cheaper and better road than any other size. It takes power to pull such a machine with a full load but the same men can operate the tractor and the grader as would be required by smaller outfits with the advantage that they move from two to four times the amount of the material and do it easier. The grading of roads with the old style horse grader is a thing of the past. Six, 8 and 10 ft. blade graders are too light to stand the punishment of continuous work. Our four outfits worked from the twentieth of March to the first of November without a stop except such as conditions imposed upon us. We really carried on the work too long in the latter part of the season, but the demand of the townships kept us going.

In grading an earth road, set stakes with the transit on the permanent ditch line and then the first round of the grader, cut the sod far enough back from the ditch line to clear the back slope of the completed ditch. Cut this sod with a light cut and move it into a line under your new shoulders. Then by successive rounds cut your ditches and move the loose earth on and over the entire roadway. To make the best job your ditch cuts should be made in the manner we speak of as stair-stepping. That is, make the first cut a couple of feet outside of the ditch line, being careful to get the cuts straight and parallel to the line of the new ditch. The second cut for deepening the ditch should be made from 6 to 9 ins. toward the road side of the first cut. The third and following cuts are made in the same manner, spreading each layer of fresh earth over into the roadway and building up the shoulders. When the ditches are deep enough, but on your back sloper and trim the back slope and clean out the bottom of the ditch. It will take two rounds of the grader to clean the ditch properly and cut the back slope. This last material goes upon the shoulders of the road and is spread from the shoulders to the center line of the road. On most of the old roads that had an excessive crown, we have not raised the center of the road. All the earth we have cut out of the ditches and from the back slope has been used in building up the shoulders to that old crowned road and giving the road a 6-in. crown.

When you have completed a mile of road in this manner you will find that

it is very loose. That is, the soil you have cut from the ditches and back slope is more or less like new cultivated soil in a field or like a garden. To finish and keep it smooth under traffic, put on a patrolman immediately. He should continually work that fresh surface under traffic and help fill the minor depressions as they appear and dress up the surface. In fact a patrolman completes the road or changes it from a fresh graded roadway to a finished subgrade.

A few of the people who visited Bureau County last year to see our grading have rather thought that a lighter grader and tractor would answer the purpose almost as well. We believe otherwise, and while the 12-ft. grader seems to be a large machine, it is not one bit too large and I believe that when a tractor is developed to draw a 16-ft. grader, that we will find we can build cheaper roads with the 16-ft. blade than we can with the 12-ft. machine.

About the cost of that work, the team work has amounted on many sections of road to more than the work of the tractors and blade grader, while the blade certainly moves many times the amount of earth in cubic yards. Our blade grader work has cost us, not counting the item of depreciation of equipment, all the way from $100 to $400 per mile. The sections of least expense were in a rather sandy country where we could not cut and did not require a deep ditch, and the heavier cost sections were where bad weather was encountered or conditions such as stumps, trees and heavy grading. It is the amount of earth you move with any machine that counts in the cost of the road. The yardage of earth moved by the blade grader has been estimated at from 1,000 to 3,000 yds. We have found it not necessary in this work to close any roads during construction, but have kept them open and the fills smooth in order to get the benefit of such traffic as we had, to help pack the roadway. In the grading of our county roads, we have cut 23 corners, to a minimum radius of 300 ft. This was done at the same time we did the other work, so the teams and blade could shape up those curves and make them a part of the new road. We have banked the turns at about 1 in. to the foot, and find them to be very fast. Some of our reckless drivers have taken them at upwards of 50 miles an hour. The first corner was rather difficult to buy because people did not think it necessary for safety and thought it gave the people a chance to speed up on the corners, but of late, the township commissioners have been coming to me and talking about some of their corners that people complain of now, as being unsafe. While we have not yet worked out a standard for the connection of the township roads with our county roads, nor township roads with county roads, it would seem that something could be done either to keep the corners clear or to round them to a smaller radius, say probably 100 ft.

The foregoing paper by Mr. Melcher was presented at the recent Superintendents of Highways Convention held at the University of Illinois, Urbana, Ill.

DETOUR PRACTICE OF PENNSYLVANIA STATE HIGHWAY DEPARTMENT

During the last three years the State Highway Department of Pennsylvania has developed a system of marking detours which has eliminated for the most part the criticism which occurred in 1919, when the department embarked on the most extensive road building program launched by any American state. Everything has an infancy—and detour marking in its infant stage was of a crude sort. As developed by the Pennsylvania Highway Department detour signs give the traveler complete information concerning not only large towns, but as to the smaller places reached by local detours.

Standard signboards are used on every detour in Pennsylvania. These are of wood, so built as to protect the signs from the soaking effect of rains. On the upper portion of the board appears the large word "Detour," a direction arrow and the words "State Highway Department." There are three different standards governing the lower portion of the board. One gives information concerning the terminus of the detour, with notations concerning intermediate points, as: "To Lancaster. Via Columbia and Mountville." A second bears the same information, and below it the further direction: "Road Open for Traffic to Salunga." This means, of course, that while the main highway is closed to Lancaster traffic, it is open for traffic going only to Salunga. The third standard contains two-way directions, thus: "To Lancaster, via Columbia," with an arrow pointing in the proper direction, and "To Lebanon, via Cornwall," with a pointing arrow. It is frequently necessary to give directions concerning points in both directions.

The lettering on all detour signs

throughout the state is now uniform. Originally blue crayons, or red, were used, and the names of towns and cities were written on white cards. The weather quickly erased these names. The result was confusion. The department has supplied each of its 15 district offices with standard stencils. With a stencil it is not possible to secure a full letter, so that the offices fill in the open spaces, completing the letters as shown in the standards. The resulting sign can be read at a considerable distance, and they are placed so that at night the beams from headlamps will reach them. It is particularly provided by the department that no sign may be placed where it will be beyond the rays from lamps, and the engineering forces, before erecting signs, cover the roads at night, to be sure the locations are right.

The signs at the beginning of the detour give complete information concerning the terminal points; those within the detour give information concerning the termini, and also local points. The colors used on the entire sign are distinctive, not only in daylight, but under lamp rays. The sign approximates 24 by 36 ins., and is mounted on a post, the height of which depends upon the angle at which the sign is reached by rays from lamps.

One difficulty encountered by the state's engineers is in keeping detour signs in position. There seem to be at large a great number of vandals who delight in tearing the tin and heavy cardboard signs from the signboards and throwing them away. Instances have been reported where the entire sign, including the post, has been torn down and carried away. In other instances persons with peculiar ideas of humor have reversed signs in such a way as to give directions exactly opposite of correct. While an effort is made to inspect the signs on each detour daily, it is sometimes impossible to do this, and the troubles encountered by travelers who see no signs are directly the result of the work of the vandals or mad wags who are having what they call a "little fun." Some trouble was had for a time with persons who imitated the department's signs for advertising purposes. In an eastern Pennsylvania county a number of roads were placarded at intersections with signs bearing a very large "DETOUR," and the smaller notification that a merchant had a piano sale. The traveler, seeing only the larger word, was far off the road when he discovered his mistake. This lack of discretion on the part of advertisers resulted in an enactment of a law prohibiting the imitation of a State Highway Department sign for any purpose.

At this time there are approximately 200 detours on state highways in Pennsylvania, and approximately half a hundred on county or township roads. In several instances there are very rough detours occasioned by work on city streets which bars entrance to a municipality. Not all detours are under the control of the State Highway Department, by any means. The standardization of detour signs makes it possible for travelers to know whether the detour is occasioned by state work or otherwise.

The State Highway Department is frequently asked why it cannot put its maintenance forces to work on township roads used as detours, so that they will be more travelable. Under the state law this is an impossibility, the department being forbidden so to spend its money. Maintenance of these roads is by the authorities who control them. The department, in the majority of contracts for the last two years, has secured agreements from counties or townships providing for the upkeep and repair of detour roads by these units, but in some instances the agreements have been ignored after actual use of the roads by detour traffic begins. The public, unacquainted with the facts, criticises the Highway Department, which is of course blameless.

One of the worst detours in Pennsylvania since 1919 was that on the Lincoln Highway between Saluvia and Harrisonville, Fulton county. Two side roads were used—one for east-bound and the other for west-bound traffic. Both roads were merely earth trails, and the heavy traffic soon cut them to pieces. Efforts of the department to secure their improvement were fruitless. Complaints were not only numerous, but very loud. However, the detour was removed over a year ago and the memory of its roughness is very faint with those who travel the three-mile concrete section the construction of which occasioned the detour. The inconvenience suffered by travelers during periods of construction is part of the cost of good roads. The topography of Pennsylvania anad the type of highway being constructed make it impractical to build half the road at a time, as is sometimes suggested.

The State Highway Department each week issues bulletins concerning detours removed and inaugurated. These bulletins are sent each daily newspaper for publication, and in addition are posted in

BEFORE — Main Street, Lena, Ill., before "Tarvia-X" construction.
Mud Disappears Where Tarvia Enters!
AFTER — Main Street, Lena, Ill., after construction with "Tarvia-X"

THIS is an era of progress. And progress follows the line of least resistance. It can never reach the community that is marooned for weeks at a time in an ocean of hub-deep mud.

Today the entire nation is aware of these facts—is alive to the need for better roads. From farm and town alike, comes the demand for durable, economical, all-year highways.

The Age of Mud is giving way to the Age of Tarvia. For in the building of good roads Tarvia is playing a leading part. Road officials and taxpayers know from experience that Tarvia roads give the most for the least money.

Economy of first cost, and economy of maintenance brings smooth, dustless, mudless, all-year Tarvia roads within the financial reach of even the most humble community.

Tarvia is a coal-tar preparation for use in building new roads and repairing old ones. It reinforces the road surface and makes it not only mudless and dustless but waterproof, frost-proof and automobile-proof. Where existing macadam or gravel can be used as a base the cost of a traffic-proof Tarvia top is extremely low.

Illustrated booklets descriptive of the different methods of applying Tarvia, will be sent free on request.

Tarvia
For Road Construction Repair and Maintenance

New York Chicago Philadelphia Boston
Detroit New Orleans Birmingham Kansas City
Peoria Atlanta Duluth Milwaukee
Youngstown Toledo Columbus Richmond
Baltimore Omaha Jacksonville Houston

The Barrett Company

St. Louis Cleveland Cincinnati Pittsburgh
Minneapolis Dallas Syracuse Salt Lake City
Bangor Washington Johnstown Lebanon
Latrobe Bethlehem Elizabeth Buffalo
Denver San Francisco

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

930 garages, motor club headquarters, Chambers of Commerce and other places where the traveling public may secure information.

TULSA TO HAVE LARGEST STORM SEWER IN SOUTHWEST

By Charles Schultz, City Engineer, Tulsa, Oklahoma

There will be constructed soon, in the City of Tulsa, Okla., what is probably the largest storm sewer in the Southwest. This will be a relief sewer to take care of the storm water draining from an area of over 2,000 acres, which will carry 3,500 cu. ft. per second that is not now being handled by the storm sewer which was constructed several years ago.

After the old storm sewer was constructed, the whole basin was covered by valuable residences anda municipal improvements of all kinds, which shortened the time of concentration of storm water to approximately 30 minutes, and caused a condition of overflow that has caused the property owners many thousands of dollars in water damages and property depreciation. Early in this year a bond issue of $900,000 was voted to remedy this condition and preliminary work was started on the design of this structure.

When the writer took charge, as City Engineer, a large amount of the data had been collected and several preliminary lines of location run. Early this summer Mr. W. W. Horner, of St. Louis, was retained as consulting engineer and suggested the feasibility of building this sewer in tunnel cut. New lines were run looking to this method of construction and estimates prepared which show that the tunnel cut is the desirable method of constructing this improvement, when the inconvenience to the public and the damage to private property is taken into consideration.

Core borings are now being made which show that the covering above the sewer will be part sandstone and part shale, considered sufficiently stable to support the roof during construction. The work will probably be carried on from two central shafts, and perhaps one end, as it is very essential that this project be completed at an early date.

The length of the entire project is approximately one mile. The run-off is being calculated by the rational method. An interesting feature in this computation was presented by the fact that no rainfall records showing the rate of precipitation were available for more than five years, so that it became necessary to use the rates of rainfall from neighboring cities where longer periods have been covered.

The arch section is being designed by the elastic theory, the work being in the immediate charge of Mr. Geo. E. Wakefield, acting with the writer.

OCCUPATIONAL INDEX OF ENGINEERING POSITIONS

The procedure in gathering, compiling and studying data relating to the engineering profession for the purpose of preparing an occupational index of engineering positions has been outlined in the first report of the Committee on the Classification of Engineering Positions recently appointed by the American Association of Engineers. This committee consists of A. B. McDaniel, educational specialist in the War Department, chairman; C. R. Mann, Civilian Advisory Board, General Staff, War Department; Prof. C. J. Tilden, Yale University; J. R. Randall, president, Rochester Mechanics Institute, and W. C. Bolin, pilot engineer, B. & O. R. R., Baltimore, Md. E. O. Griffenhagen, J. L. Jacobs, of Chicago, and Prof. H. H. Stock, of the University of Illinois, are advisory members of the committee.

The program of the committee includes: 1. The preparation of sample specifications to send out with occupational study sheets. 2. Preparation of blank occupational study sheets. 3. Sending out of occupational study sheets and sample specifications to at least 50 practicing engineers in each position to be studied, with the request that the information indicated by the study sheet be promptly furnished. 4. The compilation of data received. 5. The preparation of preliminary specifications for publication and criticism by members of the profession. 6. A study of the criticisms received and preparation of provisions to complete such specifications.

The field of highway engineering has been selected for the first study by this committee. In this field Prof. C. J. Tilden, during the past summer, while engaged as consulting expert of the U. S. Bureau of Public Roads, has obtained a large amount of valuable data relating to highway engineering positions.

The engineering occupational index should be of value in employment organizations in the selection and allocation of engineers, to licensing boards, civil service commissions, and similar organizations in the allocation of engineers, and to individual engineers.

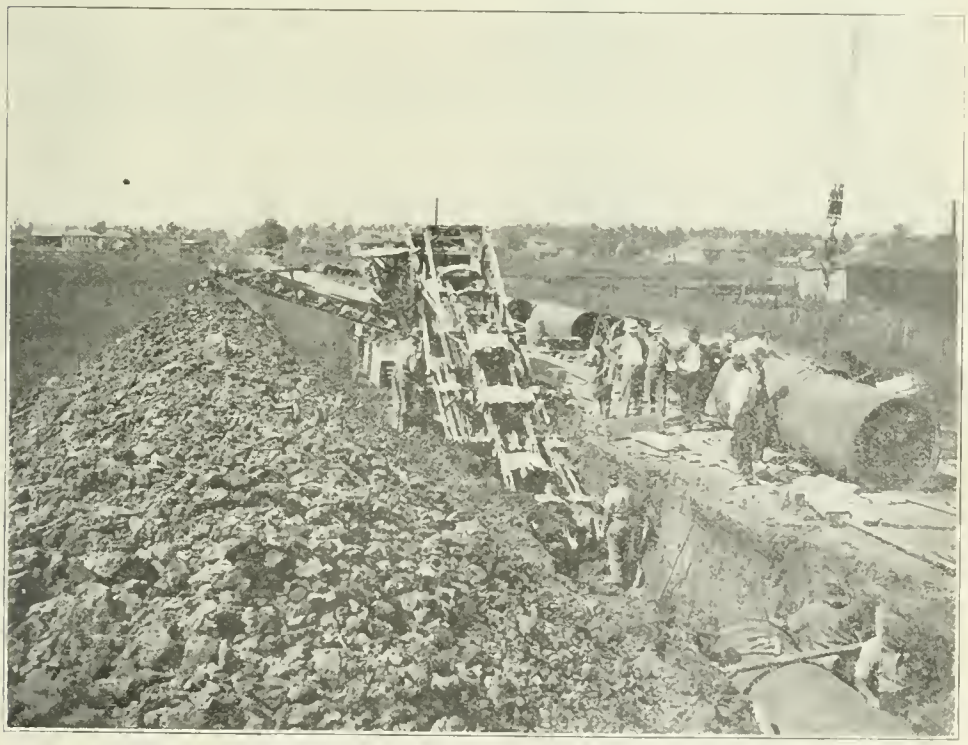
WATER WORKS SECTION

LAYING 186 FT. OF 48-IN. CAST IRON PIPE PER DAY FOR CHICAGO GAS CO.

(Editor's Note: The largest gas main in Chicago, which is surpassed in size by only two or three mains in the world, is now being laid. The main is 48 ins. in diameter, of cast iron bell and spigot pipe, and it is 4½ miles long. It will be adequate in size to serve a large section of the city, on the southwest side, for many years to come. The work has been of unusual interest to engineers and contractors. It has progressed practically without interruption at an average rate of 186 ft. of completed main per day. The Austin trenching machine has maintained a daily average of 204 ft. with a maximum record of 408 ft. The methods employed on this job are here described from information taken from the Peoples Gas Club News, the journal of the Peoples Gas Light and Coke Co. of Chicago, the Company owning the main. The rate of progress maintained establishes a new record on 48-in. pipe line construction for both gas and water utilities.)

Preliminary Work Important

The grade of the southwest side of Chicago rolls gently to the north and all drainage flows to the Drainage Canal. It was decided that an easy grade be given the 48-in. main to the north and that it follow the natural contour of the ground. Two feet of cover was considered sufficient and by grading the line to the north, no drips would be necessary as the line



NO. O AUSTIN TRENCHER, WITH SUPPLEMENTARY WIDENER, DIGGING 4½ MILES OF 7x7 FT. TRENCH FOR 48 IN. GAS MAIN FOR PEOPLES GAS LIGHT AND COKE CO. OF CHICAGO.

would drain into the tunnel shaft at 39th street.

All underground work was taken care of in advance, arrangements being made with the city waterworks department to lower their mains deep enough to allow the 48-in. main to pass over them. Telephone conduits and high voltage wires were moved out of the path.

An accurate survey was made of Hamlin Ave., along the route of the main and a profile map made showing obstructions. The proposed line was laid out on this profile map and the grade established. Test holes were dug at each street intersection so that an accurate knowledge of the obstructions would be available and on record.

Contract Work Big Item

The general contract for the construction of this main was let to Nash Bros., Chicago. The contractor digs the trench, braces it, places the pipe in the ditch, maintains the trench while the pipe is being caulked, backfills after the pipe is tested and returns the street to its original condition. The Gas Company caulks and tests the pipe. The contract for hauling and placing the pipe along the proposed route was let separately to the W. J. Newman Co., Chicago. The contractor moved his equipment, May 10, to 71st and Hamlin Ave., and the work was started digging the trench May 15.

Digging the Trench

Because the south end of the job was at the highest elevation, and the territory at the north end near the Drainage Canal was open country, having a gumbo soil, very soggy in the spring of the year, it was decided to start at the south end.

Nash Bros. sublet the excavating of the trench to G. T. Thorne of Oshkosh, Wis., who used the large Austin Excavator shown in the accompanying illustrations. This excavator digs the trench, which averages 7 ft. x 7 ft., with ease. A record of 408 ft. dug, and pipe laid has been made, on one day, and since the actual work started an average of 204 ft. per day was made up to August 1. Figuring the expansion of the dirt from the trench, the excavation is running 2 cu. yds. per lineal ft.

An interesting feature is the method of digging the sides of the bellholes as the excavator is working. Due to the digging being done on an incline, bell-holes were measured ahead and men with bars and shovels placed on each side to cut out the bell-holes. The dirt is thrown down on the buckets and carried out of the ditch, proving a great labor saver.

Bracing the Ditch

The pipe is placed in as soon as the ditch is dug, the excavator keeping a few lengths ahead of the pipe-laying. The soil is a clay gumbo and in dry weather stands up remarkably well.

A stretch of dry weather, 43 days without rain, since the job began enabled the work to be carried on very rapidly and to date only single pipe braces have been necessary at each pipe. One of the illustrations herewith shows these bracing conditions.

Placing Pipe In Ditch

For handling the pipe the contractor installed a 10-ton gasoline crane mounted on caterpillar traction. In order to lower the pipe slowly in the ditch and to assist in lining it straight, the single line on the hoist drum was reduced by means of a double set of blocks so that 1 ft. on the drum was reduced to a 2½ in. drop at the pipe.

The traction crane follows closely behind the excavator and it takes six minutes to lift the 48-in. pipe from the bank, place it in the trench, and drive it home.

Laying the Pipe to Grade

Extreme care is taken with the laying of the pipe. Each pipe weighs approximately four tons and it was decided that the trench should be dug to grade, the blocking laid so that the top of the 4-in. blocking would be on grade, which would make the whole pipe, with the exception of the bell-hole rest on the original, undisturbed bottom of the trench.

Constant engineering supervision carries out this plan. Levels are taken on the ditch as the excavator is working, on the blocking before the pipe is laid and on the pipe line after laying for a permanent record.

Digging Bell-Holes and Caulking

Our Company maintains its machinery for caulking and does this work with its own forces.

Immediately the pipe is placed in the trench, the bell-holes are dug in preparation for the caulkers. At no time during the progress of the work so far have the caulkers been more than 25 joints behind the last pipe laid.

The joints are 5 ins. deep and are caulked with 3-in. wool yarn and 2-in. lead wool. Caulking is done by pneumatic hammers and two men work to each joint. It requires approximately 8 lbs. of wool yarn and 126 lbs. of lead wool per joint. Two men average 2 joints per day; 127,500 lbs. of lead wool and 8,160 lbs. of yarn have been used so far on this job.

Compressed air is supplied by 3 Ingersoll-Rand Portable Compressors, capable of supplying a maximum of 210 cu. ft. per min. each at 100 lbs. pressure. A header line runs along the trench and two compressors work on the line. At times as high as 14 sets of caulkers, 26 hammers have worked from this header line.

A unique arrangement of the compressors and header line makes a very efficient layout. The header line is run 2 city blocks ahead of where the caulkers are working and by aid of the extra compressor, 2 compressors are always on the line when one is being moved ahead.

This means that the caulkers are never held up waiting for air while the header line is being moved ahead or the compressors being moved into a new position.

Pumping Surface Water

As precautionary measures against drainage surface water it was decided to have on the job 3 Schramm pumps having a capacity of 50 gals. per min. each. A header line was laid along the top of the trench and 12 ft. lengths of hose connected by unions to this header line and lowered into each bell-hole where there was water. This method proved very satisfactory where water was encountered.

Testing Four-Ton Pipe

The progress of the work is so arranged that the digging and laying of the pipe ends Saturday noon. All uncompleted joints are finished up Saturday afternoon and Sunday if necessary.

The 48-in. plug is put in the last pipe by means of the traction crane. When the last joint has been caulked, the 3 compressors are hooked up to the line and it has been found possible to secure 15 lbs. pressure in the line inside of 8 hours.

The tests have been cumulative up to the present time, testing each week's work in addition to the work that has been finished previously. Up to August 1 a length of pipe from 71st St., to 52nd St., on Hamlin Ave., a distance of 12,500 ft., has been successfully tested.

Backfilling With a Fire Hose

The contractor is backfilling with an Austin Backfiller and puddling the dirt by means of a fire hose connected to fireplugs at street intersections.

Excess dirt, which runs to nearly ¾ cu. yd, per lin. ft. of ditch, is being loaded by a clam-shell crane on traction wheels, into motor dump trucks and hauled away from the job to be wasted.

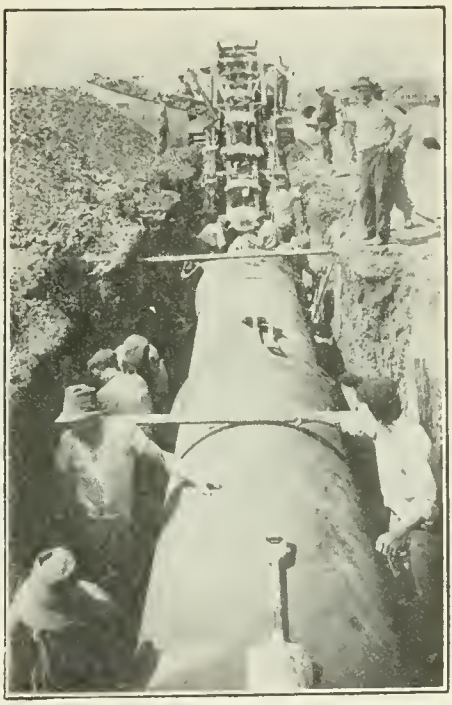
Underground Work

The route of the 48-in. main passes through some of the main water lines of the city of Chicago. At 65th St., it was necessary to lower the 30-in. water main supplying the large Clearing Manufacturing District. This main had to be cut out and lowered 8 ft.

Progress and Completion

The average of 186 ft. per day since the work started is a record for the laying of 48-in. main whether it is gas main or water main.

The Company is determined to have this main completed before the working season



DIGGING TRENCH AND LAYING 48 IN. CAST IRON GAS MAIN IN CHICAGO.

of 1922 ends. If the present rate of progress is maintained, the whole line should be laid and gas turned in it by November 1.

The laying of this 48-in. gas main is being done under the direction of John H. Eustace, chief operating engineer. W. G. Rudd, assistant operating engineer, is in charge of the engineering details. Actual supervision and construction is carried on by the Department of Streets, C. L. Day, general superintendent, through John Ginley, assistant general superintendent, and F. S. Carnes, superintendent South Division.

LAYING 36 AND 48-in. WATER MAINS IN STONY GROUND AT NEW BEDFORD, MASS.

By W. R. Conard, of Conard & Buzby, Consulting Engineers, Savings Institution Bldg., Burlington, N. J.

In arranging for the installation of some large sized water mains the City of New Bedford, Mass., figured that to facilitate the trench work and reduce the laying cost they could use some form of digging machine and after observing the work of the several types of machines used for this purpose decided that the steam shovel would be the most efficient inasmuch as a large proportion of the digging would be through soil having numerous boulders of large size which could be handled with a shovel.

Accordingly a Bucyrus steam shovel, self-propelled, was purchased, and some 6,765 lt. of 36-in. pipe was laid. Following this, plans were made for putting in about 3½ miles of 48 in. pipe line, slightly over 1 mile of which was to go in along a main traveled highway, and the balance along a private right of way belonging to the city.

This private right of way is about 8 miles long, extending from the pumping station to a large storage and distributing reservoir along which there is already in place a 48-in. steel main, and also a private line of standard guage railroad for about 4 miles, extending from the New York, New Haven and Hartford Railroad to the pumping station, and which is used by the city for transporting coal and other supplies.

That part of the new main which is along the highway starts at about the half-way point between the pumping station and the N. Y. N. H. and H. main line, and it was decided to switch the cars to this half-way point, unload them, and distribute by truck along the highway, the balance of the distance from the highway to the pumping station it was decided to switch the cars in and try and distribute direct from the cars along the private right of way.

This brought up the question of unloading the pipe, and at first it was planned to use a platform derrick at the half-way point, store there and distribute along the highway and then perhaps move the derrick in another point along the railroad for unloading and possibly distribute, if necessary, by truck along the private right of way. After considering the matter more carefully the writer recommended that a portable crane be procured so that there would be no necessity for trucking along the private right of way at least, and also because the crane when not unloading pipe could be put to use putting the pipe in the trench, and handling other materials along the line. This appearing the logical thing to do, another Bucyrus machine was purchased, this time a steam crane, with digging lines and a ¾-yd. clam-shell bucket; the traction on this crane is the continuous type of tread, known generally as caterpillar traction.

VIEWS OF HEAVY WATER PIPE LINE CONSTRUCTION AT NEW BEDFORD, MASS.

Bucyrus Steam Shovel is Shown Dumping to Motor Truck Body Direct. Bucyrus Steam Crane Used in Handling Pipe and Other Purposes on the Job.

Work was started in July, 1921, and continued through the rest of the construction season, the steam shovel continuing to prove its efficiency for this class of work, at times taking out boulders of over a cubic yard in area, and averaging around 100 feet of 6x8 ft. trench per day, at an operating cost of around $38 per day. Also the wisdom of the purchase of the crane was soon proven for not only did it unload the pipe from the cars at the half-way point, but also unloaded and distributed them along the highway, and during the intervals it was used to put in the pipe in the trench, to place backfill

with the clam shell and at odd times when wanted acted as an auxiliary to the steam shovel. In fact so many uses were found for it that during part of the time a tripod derrick, steam operated, was hired and used at the half-way point to unload the cars there, leaving the mobile apparatus free to make itself useful where most needed; the operating cost of this derrick averages $38 per day, which, of course, is spread over the entire operation.

In laying the pipe all of the trench which the steam shovel would make during the day was filled with pipe in about half the afternoon and by using square plaited hemp, which requires practically no caulking, and Leadite, which requires no caulking at all, all joints were made, and each night brought the pipe laying up to the end of the trench opened, with the backfilling to be done the following morning. The earth as excavated was landed in trucks which dumped into the trench to be backfilled a short distance behind. By this means an average of 72 ft. of pipe was laid per day from July to November 20th for that part of the line along the highway, the costs being $15.09 per foot for the pipe and specials f. o. b. cars Braleys Station on N. Y., N. H. and H. R. R., and for the unloading, hauling, trench work, laying, etc., complete, $11.49, or a total of $26.58 per foot furnished and laid.

The above can be considered a fair average as the going while not easy was not particularly difficult, and would, I believe, be representative of general conditions.

Mr. Stephen H. Taylor is Superintendent of the New Bedford Water Department, and the writer acted as consultant for the 48-in. line construction.

PULVERIZED FUEL FOR CAHOKIA STATION OF UNION ELECTRIC LIGHT AND POWER CO.

(Editor's Note.—Recent rapid developments in pulverized fuel equipment, and in the application of pulverized fuel, brings this type of fuel to a point of equality, at least, with solid fuels and automatic stokers. In fact, many engineers will even now be inclined to give preference, under certain conditions, to pulverized fuel. The following timely account of an important pulverized fuel installation is reprinted here from the September issue of the magazine, "Combustion.")

Almost directly opposite the center of St. Louis, on the Illinois side of the Mississippi River, will be built the great Cahokia Station of the Union Electric Light and Power Company. Besides being the last word, to date, in economical power production, the new station will be notable for several things which will give it a deep interest to all who are interested in the development of central stations as a source of power for the country's utilities, its industries and its transportation.

A central station of the magnitude of this one and one upon which so much scientific and practical care has been expended in its planning would have attracted a great deal of attention under any circumstances. The outstanding novelty in this plant, however, is that the source of its power is to come through pulverized fuel, rather than the means usually employed in firing the boilers which furnish steam to the large steam turbines.

For several months this central station has been planned by the engineers and constructors, McClellan & Junkersfeld, who have been determined that they would produce at this point, which is so particularly auspicious for an economical station, what would be a model station of its sort and one which would produce power with uniformity and certainty at a minimum of cost.

The engineers had before them the proposition of a sufficiency for many years of a rather poor grade Illinois coal, known as Bellville. This was available alongside the station at the low price of, probably, $2.50 per ton. The average analysis of this coal showed that it contained 10,000 B.t.u. (as received), 12 per cent moisture, 16 per cent ash and 5 per cent sulphur. The haulage would be about 20 miles from the mines, and the position of the new plant in Illinois would do away with switching and bridge charges. The coal would be used as purchased most advantageously from the mines during all seasons and under all mining conditions. It would naturally often possess various and many impurities, and might run anywhere from lumps to mine sweepings.

With this general proposition before them, the engineers began a series of tests and investigations, the like of which has probably never been equaled, as the preliminaries to the construction of a power plant. Besides all the data that could be collected and all the reports of established tests that could be learned of, independent investigations were set on foot at Cleveland, Chicago, Racine, Milwaukee and other places where opportunities for gaining knowledge from actual operations

were available. The figures gained in these tests were adjusted to a common denominator for the purpose of a proper and dependable comparison of the results. This adjustment included exit flue gas temperatures, auxiliary steam or electric power, and all other factors that were not common to each of the tests compared. Of course, these tests naturally centered around stokers and pulverized fuel. At this time only one basic fact regarding the results of these tests will be given out by the engineers and the company which is building the plant. This fact is embodied in the conclusion that pulverized fuel was determined upon as the power-giving source for the Cahokia Station.

Speaking of the general results which have caused this decision to be made, and which caused a contract to be signed with the Combustion Engineering Corporation for the installation of the Lopulco Systems in the first section of the new plant, Mr. Junkersfeld said that there were several reasons in addition to better fuel economy, some of which could be easily expressed in dollars and cents, and others which could not be so expressed, which led to the determination to use pulverized fuel.

In the dollars and cents column, as the general results of the investigation by his firm show, Mr. Junkersfeld declares should be placed first a saving in fuel by the new method above that obtainable with stokers; second, that there would be a net saving, under the Cahokia conditions, which would come through maintenance, stand-by and pick-up losses, ash removal, and operating pay roll.

Under the head of those things which cannot be easily expressed in figures the engineer spoke of the dependability of pulverized fuel, which he believed was just as good as that of stokers. The question of the quality of fuel was evidently a very important factor. It was obvious that the quality of the coal received was likely to be varied, especially as to its content and form. The satisfactory use of this non-uniform fuel means a great deal. There was a chance that it would at times become very low grade, even lower than the general run as indicated in the analyses. This was a factor which was particularly advantageous to the choice of pulverized fuel instead of stokers.

Another factor which seemed to be regarded as of great importance was that all the coal that passed through the pulverizing mills and entered the furnaces would mean heat and power, while on the other hand, such a drop in quality would be a serious factor in the performance with stokers.

Evidently the engineer also considered seriously the pronounced ability of the pulverized fuel furnace to pick up load beyond anything that the stoker fired furnace would do as ordinarily operated under average conditions. He regarded pulverized fuel in this way to be similar to oil or gas and to have their advantages. He spoke of the recent improvements that had been made in pulverized fuel apparatus and said that they all tended towards greater simplicity and ease of operation, and that this feature also made this method of burning such an important matter in the combustion world.

Apparently when pulverized fuel first presented itself for the attention of engineers, the complicated methods that were then deemed necessary in its preparation and burning did much to hold back its progress. The additional buildings or additional space which were once necessary for the complicated apparatus used in the preparation of this fuel are no longer necessary.

The whole of the pulverizing, conveying and burning of the fuel in the Cahokia Station is to be done within the same walls required by the boilers and in comparatively small space. In fact, Mr. Junkersfeld sums up the situation by saying that pulverized fuel was economical in first cost, economical in maintenance and economical in the use of fuel—so much so that these advantages made the use of pulverized fuel inevitable in the Cahokia plant.

The construction of the Cahokia plant of the Union Electric Light and Power Co. is the result of the natural growth and improvement of the city of St. Louis, which it is to help supply with power and light. It is being built to take that portion of the load over and above that supplied by the Keokuk Dam and that supplied by the present Ashley Street Station of this company. The Cahokia Station is planned to deliver ultimately 240,000 k.w., which will make it one of the great central power stations in the world. That portion of it, however, which is to be built at this time and which is to be completed by September, 1923, is one-quarter of the plant eventually to be erected and will produce 60,000 k.w.

So far as the details of this great station are concerned, the company and the engineers are not prepared to make any extensive announcement at this time. The boilers are to be Babcock & Wilcox, 20

tubes high and 38 tubes wide. There are to be no economizers, as the low price of the coal does not warrant their use. The boilers are designed for 350 lbs. pressure, with the delivery at the throttle 300 lbs. Superheaters will bring the steam up to the total of 690 degs. F. The furnace volume is to be quite large, with natural draft, and a system of water screens at both the bottoms and backs of the furnaces. The turbo-generators will be 30,000 k.w. each, one being built by the General Electric Co. and the other by the Westinghouse Electric and Manufacturing Co. The condensing equipment and all the plant auxiliaries will be motor driven. The feed water for boilers is to be heated by bleeding the main turbines. The heat balance is to be maintained by varying the load on the house turbines.

The power house itself is to be built of brick and steel. The section that will be completed in September, 1923, will be about 170 ft. long, while the whole plant when finished will be about 650 ft. long. The condensing equipment will be located in pits, two equipments in each pit, in order to operate under the 40-ft. difference in the high and low water of the Mississippi River. The entire structure will rest upon cast concrete piles, for the plant is located on very low ground between the levee and the river, parallel and adjacent to the river. This will permit of the shortest possible intake tunnel. Just at this time the concrete piles are being cast, active work is under way and it will continue until the first section of the power house is finally complete a year from now.

"Approaching a question of this sort, as we did," said Mr. Junkersfeld, "we naturally had to be judicial and unprejudiced, but nevertheless we had more confidence in stokers and had been dealing with them for years. The prejudice, as far as there was such, was in favor of stokers rather than pulverized fuel. In other words, the burden of proof was on the newer form of burning coal to prove its case." Perhaps this makes the result, which is to use pulverized fuel at the Cahokia Station, the more pronounced and the more important.

COST ACCOUNTING FOR PRACTICING ENGINEERS

By Arthur L. Mullergren, Consulting Engineer, 512 Gumbel Bldg., Kansas City, Mo.

Why are cost accounting and proper bookkeeping records necessary for the practicing engineer in the conduct of his business? This is a question that is, no doubt, in the minds of a great many of the practicing engineers.

Engineering is a science, a profession and a business. Until very recent years engineering was looked upon as a purely professional occupation and the practitioners gave no thought to the possibilities of the business methods involved. In former days the practicing and consulting engineer simply surrounded himself with a few draftsmen and a stenographer or two and handled only such engineering problems as came under his own particular line of training and endeavor. Furthermore, the engagements were largely unsolicited.

As a science, engineering has made very marked and rapid progress in, we might say, the past 30 years. The practicing specialists in each of the branches of the science as were recognized at that time, i. e., civil, electrical, mechanical and mining, handled individually their respective problems. If a project involved a knowledge of two or more of the branches of the science, several independent practitioners were engaged to carry out the particular work in which they specialized, and the entire work was co-ordinated by a business executive who probably had little or no knowledge of engineering.

As the science advanced and there appeared a demand for organized groups of specialists capable of taking entire charge of a project, the engineering firms and organizations came into being. Where formerly there were about 6 branches or subdivisions of the science, there are today at least 25, and on some of the large projects each branch of the science requires a skilled specialist, and in a great many cases all of the branches of the science are involved in the execution of the work. The Panama Canal, for instance, involved every known branch of the science in its design and construction.

Slow Advance of Engineering as a Business

While engineering as a science has advanced rapidly, as a business it has not. The engineer of the old school was given a thorough training in the fundamentals of engineering, but little or no training whatsoever in the fundamentals of business. As a result, he did not know how to use business methods in the conduct of his professional business. I repeat, engineering is a business as well as a science. In the very last few years it has been taught that business is a science.

To make a success of the engineering business, business methods must be employed. The prime object of any business

is to make a profit. How are the true profits determined in the operation of a business? From the records of the operations. Suppose there were no records kept, yet the owner of the business always managed to have a few dollars left after paying his expenses, which we will say also included his personal liivng expenses. Was a profit really made in the business? That would depend upon whether or not the owner was gradually consuming his previously accumulated capital unknowingly. His capital may have been money, goods or tools. If he is a practicing engineer, thoroughly trained in the science, with little or no money to start, you may say he has no capital. Nevertheless, he has, and the amount depends upon his knowledge and experience. Therefore, if this training and experience is not capitalized and put upon its maximum earning basis, the engineer is losing money.

Cost Accounting Essential in Engineering Practice

In order properly to determine his true earnings, the engineer must keep an accurate account of his operations in the same manner that any other business man keeps a record. There may be a difference in the kind of records, but the fundamental principles will remain the same. Cost accounting in the practice of engineering is as essential as in the industrial line. In order to keep properly accurate cost records of the various projects handled, a proper system of books must be used. The large engineering organizations of today that handle both engineering and construction keep such records, but the independent practicing engineer and the average consulting engineering organization maintain few, if any, records of their operations. Therefore, they are not able to determine whether or not the business is on its maximum earning basis.

Choice of System

The proper system to be used for any engineering business will depend upon the kind and size of organization and the volume of work handled. The larger the organization and volume of business, the more elaborate should be the detail of accounts. The records installed should be neither burdensome nor expensive to maintain, but in keeping with the business in hand and so established that the system can be expanded as the organization and business grow. The fundamental system should, therefore, be established with care. As the average engineer is not very well versed in accounting practices, he should at the start engage a certified or public accountant to establish the system. The accountant should be fully advised as to the character and extent of the business conducted at the time and the ultimate scope and possible extent. This information will enable the accountant to open a system to fit the present needs and one that can be expanded as the business warrants. In establishing the system of records the engineer should bear in mind that his activities broaden with time, so that his present activities are not altogether indicative of the future scope and possibilities.

A System Described

I am giving herewith a system that has been in use in our organization for a number of years, and as it seems to fit the needs of the engineer and is capable of expansion, it may be of some benefit to the practicing engineer. The basic records consist of the following: Cash Book, Check Record, Journal, Voucher Record, General Ledger, and Project Record.

For a smaller volume of business, all of the above records can be combined under one cover if the loose leaf record sheets are used. The loose leaf system is probably the most adaptable for an expanding business and offers the advantage of combining several or all records under one cover when only a small volume of business is handled. As the business expands, the records can easily be separated and separate covers provided for each one.

The system I am explaining embodies the use of vouchers and the voucher system is recommended. This system enables the making and keeping of an accurate distribution of all expenses and keeps a permanent record of the transaction, as well as the original invoices.

The voucher should be of such form that it can be folded into a convenient size when the original receipts are attached to it. The face of the voucher should show the payee, the voucher number, number of check by which paid, and the distribution of the charges covered by the invoice. The vouchers should be numbered consecutively and filed in numerical order. They are listed in the voucher record in numerical order, which record also shows the total amount of the voucher and the date when paid. A separate card index system is used for listing the vouchers by names of the payee, so that any voucher can be readily located.

The cash book shows the dates of all cash received, the amount, by whom paid,

and the date of deposit in the bank. The journal needs no particular explanation, but it is used in adjusting accounts and making correcting entries. The check record provides space for the recording of all checks in numerical order, the date of issuance, check number, payee and account or voucher number to which charged.

The general ledger consists of the asset and liability accounts. For the average engineering business the asset accounts would consist of the following: Accounts Receivable, Notes Receivable, Bank Statement, Petty Cash, Furniture and Fixtures, Tools and Instruments, Library, and Investments.

The liability accounts would consist of the following: Accounts Payable General, Accounts Payable Employees, and Notes Payable.

The remaining accounts would be the capital stock, or present worth, surplus, income and expenses.

The income account should be divided into "fees" and "miscellaneous," as it is advisable to keep the moneys received for miscellaneous purposes separate from the fees for professional services. The expense account should be subdivided and the extent of the subdivision will depend largely on the size of the organization. The following classification of expense account will probably serve adequately for a general engineering practice: Project Expenses; General Expense; Office Expense; Printing, Stationery and Supplies; Office Rent; Telephone and Telegraph; Taxes and Insurance; Legal Expense; Organization Dues and Periodicals; Interest Paid; Development and Advertising; and General Salaries.

The project expense would include all expenses directly chargeable to the various projects being handled, such as the resident engineers' salaries, traveling and hotel expenses for the project, blue printing supplies and time of office principals and assistants actually engaged on the particular project. The project expenses, in other words, represent the total direct expenses incurred for handling the particular project. Each project will have a separate account, so that the actual cost of handling the project can be readily determined. The remaining expense accounts are the general expenses and are properly termed the overhead expenses. At the end of each month the overhead expenses should be prorated to the various projects, according to the size and importance of the project. The total direct and overhead expenses will, therefore, represent the actual charge to each project, and the difference between this amount and the total fee received will represent the profit on the work. The project expenses can be kept in a separate loose leaf book in alphabetical order, and the sum of these project expenses would represent the total project expense as shown in the general ledger.

In order to keep an accurate cost record for each project, all assistants as well as principals should keep an accurate distribution of the time engaged on any particular job. Also, all expenses incurred, such as traveling, hotel, etc., should be filed in the form of an expense account at the end of each month, showing the distribution of the expenses to each job. This expense account and distribution of time can then be readily charged to each project.

The purpose of this discussion is to show the necessity and advantages of proper bookkeeping systems and cost accounting records for engineers, and the brief outline of the kind of a system is given merely to show that it is not an expensive nor burdensome matter to maintain proper records. It is firmly believed that if the practicing engineers kept such records in the proper manner and ascertained the true cost for handling particular classes of work, that more adequate fees would be received in a great many cases. The small fees that are received in a great many instances are due to the lack of knowledge of what it really costs to perform the services contracted for. It is, therefore, hoped that the practicing engineers will systematize their business and keep such accounts and endeavor to conduct their business along business lines, and if this is done the engineering profession in general will benefit, as adequate fees will be charged. No one desires to handle any particular class of business at a loss, and the only way to determine whether or not he is operating at a loss is to keep an accurate record of the cost of his operations.

The foregoing paper by Mr. Mullergren was presented at the Conference of Practicing Engineers recently held under the auspices of the American Association of Engineers.

UTILITY OWNERS FAVOR CONTINUATION OF STATE REGULATION

(Editor's Note.—Fifty thousand Indiana people owning stock in the public utility corporations in the State are being asked by the Indiana Public Utility Association, in a letter recently made public, to rally to the support of state regulation of public utilities, which is now under assault by vote-seeking politicians.)

"We are making this appeal for two reasons," said Charles L. Henry, president of the association. "We believe that the future stability of the industry depends on continued regulation by the state, and we feel that the safety of investments made by Indiana people depends upon regulation. Thousands of Indiana men and women have loaned money to the utility industry because under state regulation they felt sure the industry would be permitted to earn a sufficient return to pay them reasonable interest on their money. They are therefore concerned with any attack made upon the public service commission form of utility regulation."

Benefits Set out

The letter to investors of the utility industry appeals for their co-operation in educational work to show the benefits and importance of state regulation. It sets out the following arguments:

"(1) The repeal of the commission law would be harmful to you as an investor. Your securities would decrease in value the minute state regulation, by which they are controlled and established, is abolished.

"(2) State control prevents 'blue sky' operation in utility stocks, which have become first-class investments because they are issued on the authority of the state.

"(3) The average utility rate in Indiana is the lowest of 36 states having commissions.

"(4) State regulation costs the taxpayer little. The present commission the past year has collected in fees within a few thousand dollars of its expenditures.

"(5) If the commission is abolished city councils will not be equipped to make proper valuations on which a reasonable return may be provided for the security of the investor and the public. No utility can live without a fair and just return and no community can progress without well managed, amply financed and fairly regulated public utilities.

"(6) City councils would not be authorized to make rates for service outside the corporate limits. The public service commission is absolutely necessary to residents of agricultural districts. The commission alone can fix rates for telephone, light, power and other utility services which the farmers are installing in their homes."

Relationship Shown

In this connection the Public Utilities Commission of Maine has expressed in a novel and forceful way the relationship of the state, the public and the utilities.

"A public service company in its broadest sense is a partnership consisting of the state as an institution, the public as a group of customers and the company," say the commission in its sixth annual report. "The state determines the extent to which the company must go and regulates its rates, services and practices.

"The company furnishes the facilities with which these rights are exercised and services rendered. Those members of the public who constitute the customers furnish the revenue with which the company is enabled to perform these services. No public service company can exist without customers and those customers must be treated with fairness, both by the company and by the state."

PERSONAL NOTES

Frank A. Barbour, Consulting Civil and Sanitary Engineer, has associated with himself G. Gale Dixon, late Chief Engineer of the Bureau of Water Works Improvement of Akron, Ohio, under the firm name of Barbour & Dixon, with offices in the Tremont Bldg., Boston, and the Finance Bldg., Cleveland. The firm will continue practice in Mr. Barbour's specialty of hydraulic work, including water supply, sewerage and disposal of sewage, flood control, etc. Mr. Dixon has been connected with the development of Akron's water supply for about ten years; from 1912 to 1915 on design and construction of the original works under Mr. Barbour, in association with Mr. E. G. Bradbury, since which time he has been in complete charge of the enlargement of the system to meet the demands of Akron's remarkable growth.

Mr. S. F. Ferguson has withdrawn from the firm of Nicholas S. Hill, Jr., and S. F. Ferguson, Consulting Engineers, 112 E. 19th St., New York City. The firm was dissolved Aug. 31, 1922. The practice of the firm will be carried on by Nicholas S. Hill, Jr., as usual, at the above address.

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Every new telephone added to the Bell System increases the usefulness of *all* telephones, but this multiplication tends likewise to increase the complications and the expense of service. The scientists of the Bell System, to offset this tendency, are constantly called upon to develop new devices which simplify complications and keep down costs.

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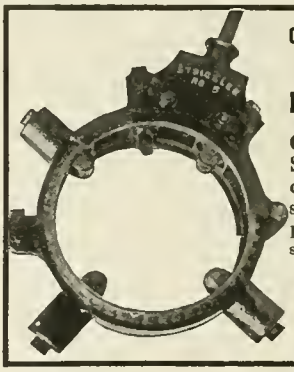

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REMOVING REINFORCED CONCRETE VENTURI VAULT WITH AIR OPERATED BREAKERS

Recently it was found necessary to remove the side wall and top of a large Venturi water vault and a section of the west wall of the Filter Building of the Cleveland, Ohio, water filtration plant.

A general view of the work, is shown herewith. The section of the west wall that was removed was 23 ft in length, 20 ft. in depth and 24 ins. thick. The wall was of concrete reinforced with ½ to ¾-in. bars, spaced on 8-in. centers. This made a very solid formation which was difficult to remove. Three days time was required to completely demolish this wall.

At the start, doing this work by hand was contemplated. However, Mr. Chas. H. McAllister, general manager of the Lake Erie Construction Co., to whom this contract was assigned, tried out an Ingersoll-Rand CC-25 "Paving Breaker." The "Paving Breaker" is an automatic compressed air operated pick and chiselling machine. It is similar to a non-rotating hand-hammer rock drill. It is light, extremely simple and operated by one man when working downward. In this particular case, however, it was found advantageous to use two men to each machine. Until lately "Paving Breakers" have been principally used by street railway, telephone, electric, power and gas companies for tearing up pavement of all kinds, for the laying and repairing of street railway tracks and the laying of electric cable ducts, gas mains, etc.

It required three days' time to completely demolish the west wall by the use of the two "Paving Breakers." As stated, two operators were used on each machine. The "Paving Breakers" not only broke up the concrete in pieces large enough to be handled by one man, but with the aid of a cutting chisel they also cut off the steel reinforcing side rods. These cutting chisels were similar to those used for asphalt except that the edge was concave so that it would not slip off the bar.

The side walls of the vault are 12 ins. thickness, 51 ft. long and 10 ft. high. They are reinforced in the same way as was the west wall of the filter building. These walls were removed in seven days by the use of the "Paving Breaker." The

REMOVING REINFORCED CONCRETE VENTURI METER VAULT WITH COMPRESSED AIR OPERATED "PAVING BREAKERS," AT WATER FILTRATION PLANT, CLEVELAND, OHIO.

roof of the venturi vault which was of the same dimensions and construction as the side was removed in 3½ days. This work would have taken many more men and a much longer time if hand methods had been used, and would of course, have been much more expensive.

We are indebted to Mr. M. A. O'Brien, Secretary and Treasurer of the Lake Erie Construction Co. of Cleveland, Ohio, for this information and for the photograph of the work. This work is in charge of Supt. Wm. Maloney of the same company.

HOW NORTH CAROLINA HIGHWAY COMMISSION MAINTAINS MOTOR EQUIPMENT

By Charles D. Farmer, Superintendent of Motor Equipment, North Carolina State Highway Commission, Raleigh, North Carolina

(Editor's Note: North Carolina has received about 750 war trucks, through the Department of Agriculture, ranging from the lightest type to the 5-ton Liberty, and 225 touring cars. There is at the "Truck Patch," maintained by the State Highway Commission, a complete machine shop, touring car and truck shop, all equipped with government furnished material. The present article by Mr. Farmer, telling how North Carolina cares for its motor equipment, is from a recent issue of the North Carolina Highway Bulletin.)

After a truck or car is allotted to North Carolina, it is driven away from the camp, or shipped, depending on proximity to the Truck Field. The car upon being received is entered on the inventory and a card made for the perpetual inventory file, and the car stored in the field, until such time as it is selected to be put through the shop. The perpetual card system carries all detailed information, such as: date received from Government, condition upon being received, the number of the shop job under which it is overhauled, the date that it was delivered to any particular district, the date of inspection by traveling inspectors, and the date of return by any district to Truck Field. The same information then follows the truck through another overhauling and issue. The cards are arranged numerically thus giving ready reference to the history of any particular truck or car.

The next move after a truck has been received is the selection by the shop foreman for its trip through the shop. The truck or car is put into the shop, the clerk giving a job card with number, of which he keeps a record, then the mechanic, assigned to the job, begins dismantling. The shop inspector checks off on the job card such parts as are to be overhauled or repaired, such as wheels, chassis, motor, radiator, or if general overhauling he so marks the card of instruction and the mechanic is governed accordingly.

The mechanic after dismantling the truck makes a list of such parts as he will need to replace broken or worn part. The shop foreman then makes requisition on the stock room for such parts, retaining in the shop the duplicate sheet which is filed with the job while open. The mechanic receives necessary parts from the stock room and signs requisition as receipt to stock room clerks for parts issued.

The time cards of mechanic and his helper, after being O.K'd by shop foreman, are filed in the envelope containing card of instruction, the duplicate of requisition on the stock room. During the time that the job is open the foreman and shop inspector pass on the work and note the progress of the job. After being finished the truck is turned over to the inspector for the road list. If the operation and condition of the truck are satisfactory the job is passed on. If, however, anything is found to be wrong or unsatisfactory the job is turned back to the mechanic.

Upon the final completion of the overhauling the car is parked among those ready to be issued to the various districts. The shop job is turned into the office, where the pricing or inventory clerk takes it into hand. This clerk gets the original requisition from the stock room clerks and compares it with the duplicate from the shop, then prices various items and deducts from inventory of stock on hand. The complete job records of parts and time is totalled, and turned over to the general ledger clerk, who in turn enters on the shop job record, then to the general ledger of distribution of charges. All repairs or overhaul jobs on trucks or cars, received from the Government are charged to "Original Repairs." This account for the first year of operation amounts to approximately $225,000, and covers all of the equipment issued out to the districts.

The perpetual, numerical inventory of trucks carries the job number, which refers to the shop job record, which in turn refers to the original shop records as turned into the office by the shop foreman. By reference to these records any information desired is at hand, so that in case of

any future complaint the true facts can be obtained, both as to the mechanic, the parts used and repair work done, and the O.K. of shop inspector, shop foreman, and road inspector.

Upon authority a truck or car is issued to any department or district, by a blue card issued by the office, carrying the make, motor, serial numbers, amount of gas or oil and accessories. The shop foreman O.K.'s this card, the office, after receiving signature of the one driving the equipment away, O.K's the card, then the gate keeper after inspection and verification of all numbers and information O.K's the "blue card."

The delivery now having been completed the blue card is turned into the office, at the end of the day with list of all deliveries, by the gate keeper and a new record is started on the truck or car, that is the record of operation.

The driver of each piece of equipment is required to make daily reports of all gas, oil, grease and repairs used to the Department or District Office. They in turn make weekly report to Motor Equipment Department Office, on blanks furnished, concerning each day's operation costs, work done and if idle the reason therefor. These reports are posted in detail on the "Individual truck record ledger." making a complete, permanent record of truck cost of operation, work done and miles traveled.

At the end of each month the record of each truck is totalled, the aggregate of the individual trucks and cars taken, thereby giving total cost of the Departments or Districts touring cars, trucks and tractors. These district records are then compiled into grand total for the State, and we arrive at the monthly cost per mile to operate touring cars, trucks and tractors. This monthly aggregate being added to previous months gives average cost covering any particular period of time, or the fiscal year or any part thereof that may have transpired.

When a truck or car is turned back into the Truck Field for exchange for a new truck or for overhauling, the same operation is gone through with in the process of getting it ready for re-issue, except that all charges for overhauling or repairing are charged to the particular work that the piece of equipment was on at the time it was turned in, either to Federal Aid Construction, State Highway Construction, Maintenance or Administration, in any given district.

It has often been stated, by those not acquainted with cost of preparing Government trucks for service, that it would have been cheaper and better to have bought new trucks than to have attempted to put into operation the trucks and cars given by the Government. On June 15, there were out in the State in service, and service of the very hardest and most trying kind, 221 touring cars, 392 trucks, 28 tractors and 41 motorcycles. Fixing the average purchase price of these, if they had been bought new, at $3,000 for trucks, $500 for touring cars and $150 for motorcycles and $4,000 for tractors, the total cost would have been; trucks $1,176,000, touring cars $110,500, motorcycles $6,150 and tractors $112,000, making a grand total of $1,404,650. We have seen that original repairs to date are $225,000, a saving of $1,179,650. This is a very conservative cost of such equipment as is now out in the State in service, and does not take into consideration any of the hundreds of pieces of equipment now stored at Truck Field, that have never gone through original repairs.

There are at present two traveling inspectors out in the State, who systematically go over the equipment in each district. These inspectors are authorized to stop and inspect any piece of equipment belonging to the State Highway Commission. Trucks are closely inspected and a detailed report made to the superintendent of Motor Equipment, a copy of the report being furnished to the district engineer, and another copy retained by the inspector.

The inspectors instruct drivers in the proper care and maintenance of equipment, and recommended any repairs or changes that they deem necessary. This system of inspection enables the superintendent of Motor Equipment to keep in close touch with all equipment and to know conditions surrounding each individual car or truck.

VALUABLE TRADE LITERATURE

Excavator and Loader.—"Lower Your Excavating Costs" is the title of an illustrated folder recently published by the T. L. Smith Co., of 1180 32nd St., Milwaukee, Wis. It features the fact that contractors who are using these machines for many kinds of work—drag-line excavating, cellar digging, excavating sand and gravel, stripping, and miscellaneous earth handling—are saving considerable time and money. Illustrations show how contrac-

tors are able to keep their wagons out of the hole and how they eliminate the need for building and maintaining an incline. The new truck-type, 4-cylinder motor of 4-in. bore and 5-in. stroke, now used, is also shown.

Chemical Lime.—"Lehigh, the Chemical Lime," is the title of a 20-page 6x9-in. pamphlet recently issued by the Lehigh Lime Co., 111 West Washington St., Chicago. It deals primarily with progress in the manufacture of lime and discusses the characteristics, advantages and uses of Lehigh chemical lime and hydrated lime.

Concrete Road Reinforcement.—A 6-page folder on the use of flat sheets for reinforcing concrete roads has been issued by the Truscon Steel Co., Youngstown, Ohio. Special reference is made to the fact that Pennsylvania and New York always specify flat sheets. Truscon Dowel Contraction Joints and Truscon Curb Bars are also illustrated and described. Attention is also called to the use of Truscon Standard Buildings for housing the machinery and storing the utensils used in municipal and county construction and maintenance work.

Speed Controller for Motor Vehicles.—The Hill Automatic Speed Controller for automobiles and trucks is illustrated and described in a folder recently issued by Henry C. Hill, 621 Main St., Cincinnati, Ohio. The controller may be driven from a front wheel like a speedometer. It can be adjusted to limit the speed of the machine from 12½ to 40 miles per hour, but permits the motor to run at its maximum speed and power capacity while making up grades with heavy loads. The device has been thoroughly tested and perfected under service conditions.

"Trail-Ford, the Super Truck," is the title of a small illustrated pamphlet recently issued by the Automotive Utilities Corp., 408 Detroit Savings Bank Bldg., Detroit, Mich., pertaining to a trailer especially designed to be attached to a Fordson tractor. The trailer may be easily equipped with a Winsor gravity end or side dump body, platform stake body, street flushing or water tank, etc.

Texaco Asphalt Macadam.—The Texaco Asphalt Macadam booklet has been slightly revised and was recently reprinted, the original edition having become exhausted. The booklet contains much of interest concerning the asphalt macadam road and is of practical value. It was prepared especially for the busy man whose time for reading is limited. It gives the essential information clearly and adequately, but in brief form. Every step in the construction of an asphalt macadam road is illustrated.

Crawler Crane.—The Link-Belt Crawler Crane is illustrated and described in literature recently issued by the Link-Belt Co., 910 S. Michigan Ave., Chicago.

Truscon Building Products.—A 100-page, 3½x6-in. booklet on Truscon Building Products has been issued by the Truscon Steel Co., Youngstown, Ohio. It contains illustrations and descriptions of all the numerous forms of Truscon building products and their uses. It also contains much tabular data for the use of designers.

Snow Plow.—The Champion V-Type Snow Plow is illustrated and described in a 4-page pamphlet recently issued by the Good Roads Machinery Co., Inc., Kennett Square, Pa. The pamphlet, designated as Bulletin K. D. V., shows close-up views of the snow plow and its use. This type of plow is especially designed to attach to heavy tractors with sufficient power for pushing through heavy masses of snow.

Power Hoe.—The Link-Belt Power Hoe, for storing and reclaiming materials, is illustrated and described in booklet No. 444, recently issued by the Link-Belt Co., 910 S. Michigan Ave., Chicago. The Power Hoe makes possible the storage and reclamation of coal, gravel, sand or similar materials at a very small cost per ton handled.

Steel Pipe Couplings.—Dresser Steel Pipe Couplings for Water Lines are fully illustrated and briefly described in a folder recently issued by the S. R. Dresser Manufacturing Co., of Bradford, Pa.

How to Construct a Sheet Asphalt Pavement.—No highway builder's file is complete if it does not contain a description of the construction of a Sheet Asphalt pavement, the highest type of asphaltic construction. Perhaps you have laid this type of pavement; possibly you have not. In either case you will find the "Texaco Sheet Asphalt" booklet to be a valuable addition to your file. Simply, thoroughly, directly, it tells its story. And it makes a neat and attractive appearance which is in keeping with any road builder's file. It is illustrated by photographs and cross-sections which bring out the important points in the text. It is published by the Texas Co., Asphalt Sales Dept., 17 Battery Place, New York City.

Contracts Awarded

ROADS AND STREETS

Ala., Carrollton—Thompson & Donahoo, Tuscaloosa, Ala., awarded contr. for road constr. in Pickens Co., at $60,000.

Ariz., Holbrook—Winsor & Frost, St. Joseph, awarded contr. to constr. Holbrook-St. Johns Hwy.; FAP 42, at $37,291.

Ariz., Tucson—Goodman Merrill Co., St. David, awarded contr. for surfacing highway bet. Superior and Florence—about 5 miles, at $28,965.

Cal., Fresno—T. A. Hanrahan, Griffith-McKenzie Bldg., Fresno, awarded contract to pave 10.14 mi. county hwy. on Biola Rd., at $168,999.

Cal., Glendale—Geo. R. Curtis, 2440 E. 26th St., awarded contract for paving Harvard, Hawthorne and Orange Sts., at abt. $24,059. Ducey & Breitenstein, 151 S. Hill Ave., Pasadena, award. contr. for paving W. Bway., Concord St. and San Fernando Rd., at $23,080.

Cal., Los Angeles—W. L. Miller, 756 S. Broadway, awarded contr. for paving Holly Dr., at $2,420; Napier & Simpson, San Fernando, contr. for grading roadway and constructing walks, etc., in 105th, 106th, 107th and 109th Sts., Budlong, Normandie, Harvard and Western Aves., at $57,694; L. A. Pavg. Co., 2900 Santa Fe Ave., contr. for paving portion Vernon Ave., at $5,558; Fairchild-Gilmore-Wilton Co., L. A. Ry. Bldg., awarded contr. for paving Grand Ave.—4th to 24th Sts.—San Pedro, at $88,627; also contr. for paving portion of St. Andrews Pl., at $31,277.

Cal., Orange—Wells & Bresslar, Santa Ana, awarded contr. for paving Chapman Ave.,—Cambridge St. to east city limits—with 8-in. cem. conc. and belt finish wearg. surf; also constr. of two culverts, at 27 75c sq. ft. for paving, $500 for culverts. Job is 4,600 ft. long, 42-ft. streets, approx. 202,000 sq. ft.

Cal., Pasadena—Ducey & Breitenstein, 151 S. Hill St., Pasadena, awarded contract for impvt. of Raymond Ave.,—Orange Grove Ave. to Dakota St., Pasadena, at $118,890.

Cal., San Diego—Louis Salcido, La Jolla, awarded contract for paving Roosevelt Mem. Dr., no. of La Jolla, at $24,840, involving about 108,000 sq. ft. 5-in. cem. conc. pavement at 23c ft.

Cal., Sacramento—Isbell Constr. Co., Fresno, awarded contract for grading 11.31 miles of highway bet. Chester in Plumas Co. and Westwood, Lassen Co., at $116,227. Geo. Pollock Co., City, awarded contract for grading 3.28 mi. 21-24 ft. roadway in Ventura Co. bet. Hueneme Rd. and 3¼ mi. s.e., at $33,640.

Cal., Stockton—Clark & Henery Co., Stockton, awarded contr. to constr. asphalt conc. surface rd. in Santa Clara Co., 4.35 miles long, at $48,588.

D. C., Washington—Cranford Paving Co., City awarded contr. for paving with asphalt a number of sts. here at approx., $75,000.

Fla., Gainesville—Hutton Engrg. Co., awarded contract to lay sheet asph. and asph. conc. at $375,000.

Fla., Quincy—W. P. Kennedy Constr. Co. King St., awarded contr. for impvt. of Jefferson, Roberts, King and Washington Sts., at $77,582.

Ga., Savannah—Dixon Contracting Co., Savannah, Ga., awarded contract for paving various thoroughfares at $233,000.

Ill., Glen Ellyn—E. M. Schoflow, Elgin, awarded contract for paving Western Ave. here, at $95,000.

Ind., Crown Point—H. P. Downey, Hammond, awarded contr. for the Adolph Lottes Rd., in Center, at $39,585; Henry Hathoway, Lowell, awarded contr. for Emerson O. Sutton Rd., in West Creek, at $34,900; See Teaming & Supply Co., Hammond awarded contract for Hawkinson Rd., Hanover, at $33,750; Courtright, Heiney & Wheeler, awarded contract for the Geo. Milcher Rd., in Winfield, at $35,000.

Ia., Sioux City—M. L. Flinn, awarded contract by City Council, for paving Country Club Place streets, at $80,000. Vibrolithic concrete will be used.

Ia., Waukon—Thos. Carey & Sons, E. 6th & Market, Des Moines, awarded contract for 50 blks. asph. conc. 5-in. base of conc. and 2-in. asph. top

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at $2.41 per sq. yd., 24-in. curb and gutter at 88c. Total, about $134,098.

Ky., Frankfort—Costello Bros., Knoxville, awarded contract for 8.3 miles on Greenville-Nortonville Rd., Greenville, west, at $42,054; Bremen, Costello Bros. contr. for 6 miles on Central City-Calhoun Rd., Muhlenberg Co., at $42,910.

Ky., Louisville—Bd. of Awards let contracts as follows: Louisville Asphalt Co., at $90,000 for paving portions of Berkenmeier Ave., Keats Ave., 23rd St., Walnut St., Rawling Ave., Zeigler Ave. and Struck Ave.; Henry Bickel Co., contr. for paving portions of 6th, Howard, Rosewood streets; also fill sq. called quadrant from Edenside to Eastern Parkway, at $46,000.

Ky., Louisville—Following road contracts let by State Hwy. Commission: R. G. Hill & Co., awarded contr. for Catlettsburg-Louisia Rd., Boyd Co., at $202,539; (pen. sandstn. base, vit. pipe); Dempster Constr. Co., Paintsville-Saylersville Rd., Johnson Co., at $161,138; also contr. to same firm for Beattyville-Irvine Rd., Lee Co., at $115,258; U. S. Tackett, contr. for Hyden-Hazard Rd., at $57,240; Dempster Constr. Co. contr. for Sec. A, Jenkins-Haymond Rd., Letcher Co., at $45,102; also contract for Sec. B, Letcher Co., Ermine-Mayking Rd., at $41,625, and Salyersville-Paintsville Rd., Magoffin Co. at $82,996; Costello Bros. Co., contr. for Sec. B, Muhlenburg Co., Central City-Calhoun Rd., at $42,910; also contr. for Sec. C, Greenville-Mortonville Rd., Muhlenburg Co., Sec. C, at $42,054; Southern Oil & Tar Co., contr. for Mt. Vernon-London Rd., Rockcastle Co., at $67,270; Dempster Construction Co., Pikesville-Williamson Rd., Pike Co., at $41,450; bridge constr. in Johnson Co. (Big Paint Crk.) and Lee Co., (Big Sinking Crk.) to Brooksville Bridge Co., at $13,911 and $6,240; Paint contract to E. E. Price & Co., Nicholas Co., at $33,858, Maint. contr. Warren Co. to J. B. McClellan, Bowling Green, Ky., at $13,509; surface treat. Bath Co., to Eaton Oil Wks. Boyle Co., contr. to Southern Oil & Tar Co., on tar, Eaton Oil Wks., Clark Co., on oil; R. B. Tyler & Co., contr. on tar Franklin Co. Southern Oil Co., contracts on tar in Hardin, Hart, LaRue, Madison Counties; R. B. Tyler Co. on tar in Woodford Co.

Ky., Louisville—A. J. Wardrep, awarded contract for 5.91 mi. St. Hwy. in Cumberland Co., N. C., at $161,275.

La., Baton Rouge—M. L. Bonner, New Orleans, La., awarded contr. to build gravel surf. rd. from city limits to Weller Ave at $130,000.

Md., Baltimore—State Roads Comm. let following contracts: 2.01 mi. conc. rd., Frederick Co., to Bester, Gosnell & Russell, Hagerstown, Md., at $63,201; 2.95 mi. conc. rd. Allegany Co., to S. T. Brotemarkle, Cumberland, Md., at $120,818; St. Marys Co., 3 mi. gravel rd. from Harper's Cor., toward Laurel Grove., to St. Mary's Constr. Co. at $20,736; 1.03 mi. conc. rd. Anne Arundel Co. to Christhilf and Ensey, 1625 Ridgely St. Baltimore, at $25,504; Prince George's Co. 1 mi. conc. rd. to Ward and O'Connell, New Amsterdam Bldg. Baltimore, at $27,248, Dorchester Co. 1 mi. conc. rd. near Lloyds, to Phillips & Neal, Hurlock, Md.; 2 mi. gravel rd. near Lyons Cor., Charles Co., to H. S. Swann, La Plata, Md., at $27,848; Hartford Co., 1.89 mi.—Aberdeen toward Stepney, to Development & Constr. Co., American Bldg., at $55,543; Worcester Co., 1.72 mi. from Bishopsville to Bishop Sta., to Juniata Constr. Co., Philadelphia, at $44,445; Montgomery Co. .97 mi. Flower Ave., Takoma Park, to Corson & Gruman, Washington, D. C., at $26,517; Garret Co. 1.99 mi. from Gortner to Red House to F. J. Denison So., Washington, D. C., at $60,836; Somerset Co., 1.8 mi. from Marion toward Tulles Cor. to D. A. Hannaman Constr. Co., Salisbury, Md., at $49,542.

Mich., Holland—Gable & Gable, awarded contract by Ottawa Co. Rd. Commrs. for bldg. 8½ miles state reward road on trunk line M89, at $76,600.

Minn., Madella—Johnson, Drake & Pipe, 905 Plymouth Bldg., Minneapolis, awarded contr. for paving streets, at $88,537.

Mo., Benton—Norman Davis, Sikeston, Mo., awarded contract by St. Hwy. Dept. to build 16 ft. gravel hwy. across Scott Co. through Sikeston, FAP No. 5, at $83,007.

Mo., Kennett—W. A. Leach, Poplar Bluff, Mo., awarded contr. for bldg. 17 miles conc. highway at $260,000.

Mo., Kansas City,—E. L. Meek & Co., Kans. City, Mo., awarded contr. for hard surfaced road in Jackson Twp., at $82,691.

Mo., Poplar Bluff—W. A. Leach, local, awarded contract for constr. of a stretch of conc. hwy. near Kennett, 17 mi. at $260,000.

Mo., St. Louis—List & Gifford, Alton, awarded contract for paving Wood River-Edwardsville road, at $118,037.

Mo., St. Charles—Strubel & Helmick Contracting Co., Alton, Ill., awarded contract for paving Clay St. and putting in curbs and gutters, at $79,745.

Neb., Newman Grove—Asplund Constr. Co., Tecumseh, awarded contract for paying streets here at $46,978.

N. Y., Brooklyn—Following contracts let: Repaving Church Ave. to Borough Asphalt Co., 407 Hamilton Ave., at $27,013; Porter Ave., etc., and Ralph Ave., Macon to Atlantic Ave., to Sicilian Asph. Pavg. Co., 41 Park Row, N. Y. C., at $3,215 and $56,340, respectively.

N. Y., Watertown—G. Aubrey Smith, Lowville, awarded contract to build 3-mile stretch of conc. hwy. to be laid on Lowville end of Lowville-Carthage Rd., at $88,689.

N. C., Charlotte—Noll Construction Co., awarded contract to construct 7 miles Yorkville Rd., hard surfaced, at $186,000.

N. C., Graham—Elliott, Sholes & Co., Durham, awarded contract for grading and conc. paving 4 miles rd. at $97,700.

N. C., Henderson—R. G. Lassiter & Co., Oxford, N. C., awarded contr. for Warrenite bitulithic paving here, at $189,720.

Wentworth, N. C.—Noll Constr. Co., awarded contract to build 7 mi. on Yorkville Rd., at about $186,745.

O., Cleveland—Roehl Bros., awarded contracts by County Commrs. for 5 miles new brick paving on Lorain Ave. and Riverside Rd., in West Park, at $524,000.

O., Columbus—T. P. Fitzgerald, Ashtabula, awarded contract for grading, bridging and paving with brk. 10,297 mi. Sec. "C-1" Painesville-Warren Rd., Ashtabula, at $299,077.

O., Toledo—Following contracts for constr. of roads let by Co. Commrs.: Upton Ave., sheet asph. to Continental Bitumen Co., at $114,191; Cone St., $12,768, rein. conc., to J. K. Sheridan; Milburn Ave., $6,440, rein. conc., to Thos. F. Carrigan Co.; Freeman St., $20,811, rein. conc., to J. M. Sheridan; McCord Rd., $66,496, bitum. macadam, to Warner & McKechnie; Reynolds Rd., $34,898, bitum. macadam, to Arthur Langenderfer; Wychwood Rd., $12,331, rein. conc., to Peters Bros.

Okla., Okla. City—Green Constr. Co., awarded contract by St. Hwy. Dept., to build 7 miles 7-in. one course conc. surf. rd., west towards El Reno to Canadian Co. line, FAP., at $226,000.

S. C, Sumter—Pritchard, Raines, Hazlehurst, Savannah, Ga., awarded contract for constr. of 7½ mi. hwy, 5-in. conc., covered with 2-in. asph., at $215,000.

N. Y., Brooklyn—Following contracts let: Repaving Church Ave., to Borough Asphalt Co., 407 Hamilton Ave., at $27,013; Porter Ave., etc., and Ralph Ave., Macon to Atlantic Ave., to Sicilian Asph. Pavg. Co., 41 Park Row, N. Y. C., at $3,215 and $56,340, respectively.

Ore., Roseburg—A. C. Hanson, awarded contract for constr. of Scottsburg-Hill Crk. Section of Roseburg-Reedsport Hwy., at $52,378.

S. C., Charleston—Poe Constr. Co., Greenville, S. C., awarded contract to build 2.171 mi. plain conc. rd. at $55,000.

Tenn., Nashville—J. F. Marcum & Co., Knoxville, awarded contr. for surfacing 10.04 mi. road from Rockwood to Kingston, FAP. 85, Roane Co., at $277,309.

Tex., Breckenridge—McCollum Constr. Co., Fort Worth, Tex., awarded contract by Stephens Co., to asph. surface 17 mi. Breckenridge-Ranger Rd. thru Co., at $200,000; also contr. for constr. of waterbound macadam base with penetration top on 17 mi. Eastland Rd., at $92,868.

Tex., Cameron—Thomas & Ratcliff, Rogers, Tex., awarded contr. to gravel surf. 17.94 miles St. Hwy. 36, at $80,743. County to furnish 39,765 cu. yds. surfacing.

Tex., Dallas—Tibbets Constr. Co. awarded contr. for gravel conc. pavement on Sengoville Rd., at $71,507.

Tex., Georgetown—Contracts awarded as follows for road work: 11.6 mi. gravel surfacing on Taylor-Thorndale Rd., 18 ft. wide and 12 in. thick, to Henry Kyle, Hutto, at $76,596; 9.4 mi. gravel surfacing on Georgetown-Jarrell Rd., 16 ft. wide and 10 and 12 in. thick, to McDonald & Evans, Austin, at $51,433.

Tex., Edinburg—Uvalde Rock Asph. Co., City Natl. Bank Bldg., award. contract to build 34.5 miles State Hwy. 12—Edinburg to Brooks Co. line; gravel surfacing with 1-in. bitum. topping, at $250,000.

Tex., Waco—Wear & Thomas, Rogers, awarded contract for gravel macad. with asph. treat. on Dallas Rd., at $164,762; also constr. of portion of Mart Rd. with asph. surf. treated gravel, at $58,834. Surfacing will be done by Finley Method Co., Atlanta, Ga. Texaco asph. will be furnished by County. Manton Hannah, Co. Engr.

Wash., Bellingham—Denning & Burnet, awarded contract to build 9.1 mi. of road in Mount Baker Dist., at $169,061.

Wash., Seattle—A. Tocco & Co., awarded contract for paving 3rd Ave., N. W., at $178,742.

SEWERAGE AND SEWAGE TREATMENT

Ark., Pine Bluff—McEachin & McEachin, Little Rock, awarded contract for constr. of sewers in Dist., at $52,000.

Conn., Bridgeport—Sewer Comn. let contract for storm, san. and comb. type sewers in Park, Essex, Horace, Bradley and Kent Sts., Ridge and Sage Aves., to Bridgeport Constr. Co., 983 Broad St., $30,092; Harvard, 5th, Hope, Monroe, Clarkson, Dixon, Kelsey Thorne, Willow & Hewitt Sts., Nash & Church Lanes, Garden Ter., Davis & Jewett Aves., to Pierce Mfg. Co., 785 Housatonic Ave., at $21,175.

Fla., Miami—Deer & Co., Miami, awarded contract for san. sewer construction, at $150,000.

Ind., Portland—Kohlsbarger & Hoyle, Marion, awarded contract for Miller Branch sewer, at $66,396.

Ia., Sioux City—D. E. West, Sioux City, awarded contract for construction of extensive storm water sewer on Harrison St. Leeds, at $35,000.

Kans., Kansas City—T. M. Torson Constr. Co., awarded contr. for construction of largest storm sewer in Kansas City., at $145,810. Sewer will be constructed of brick and will be 2 miles in length, diam. 72 ins. at outlet.

Ky., Louisville—H. Bickel Co., 443 Garden St., awarded contr. for sewer and drain in Speed Ave., at $64,470; 44th St. and Parker Ave., sewers to C. H. Cahill, 1540 9th St., at $27,999.

Mich., Detroit—Contract let to W. Blanck & Co., 823 Ford Bldg., for Lat. sewer 3515, at $9,945; 3673-A, $36,561; 3678, $10,490; 3683, $14,471; 3691, at $11,892; Lennane & McIlvenna, 1205 Book Bldg., contr., for 3672, at $15,500; 3685, $8,000; 3687, $3,000; 3693, $5,900; 3698, $6,900; Detroit Drainage Constr. Co., Penobscot Bldg., 3676, at $15,775.

Minn., Brainerd—Riches & Son, Superior, Wis., awarded contr. to construct new san. and storm sewer in southeast Brainerd thru a ravine to the river, at $38,908.

Minn., Eveleth—Lawrence McCann, Eveleth, awarded contract for septic tank, at $257,900.

Neb., Grand Island—Sewers and sewer disposal plant, Sects. 1 and 4, awarded to M. J. Peterson, 1119 S. 35th St., Omaha, who sublet same to Ward and Weighton, 516 Davidson Bldg., Sioux City, at $61,846; Sec. 2 to C. L. Hansen, Charles City, Ia., $131,274; Sec. 3 to Chambers Constr. Co., Grand Island, at $41,181; Sec. 5 to Hansen & Willodsen, Omaha, at $35,718.

Neb., St. Francis—Asplund Constr. Co., Tecumseh, awarded contr. for sewer and disposal plant, at $35,953.

N. J., Hackensack—Public Service Production Co., awarded contract for bldg. sewer disposal plant here, at $481,000.

N. Y., Mt. Kisco—Contract for resanding existing filter beds and (2) constructing new filter beds at Mt. Kisco sewage disposal plant near here. Westchester Co., to Carroll Contg. Co., 103 Park Ave., New York. (1) $38,426; (2) $42,987.

Okla., Okla. City—Smith Bros., Dallas, Tex., awarded contract for constr. of Lee Ave. sewer, at $490,309.

Pa., Pittsburgh—Christ Donatelli awarded contract for Spring Garden Ave. sewer sys., at $39,072.

S. C., Charleston—Bryan & Co., Jacksonville, awarded contr. for extension and completion of sewerage sys., at $371,895.

S. Dak., Gregory—E. M. Scheflow, Elgin, Ill., awarded contract for sewer, at $62,000.

Wis., Milwaukee—Midwest Constr. Co., Milwaukee, awarded contr. for constr. of 1st intercepting sewer of Metropolitan Sewerage Comn., at $113,776. Sewer will be 7,900 ft. long.

WATER SUPPLY AND PURIFICATION

Cal., Dinuba—Pittsburgh-Des Moines Steel Co., Rialto Bldg., San Francisco, awarded contract for erecting steel tank and tower for water works system, at $13,425.

Cal., Marysville—Bent Bros., 1714 Eagle St., Los Angeles, awarded contract to constr. concrete constant angle arch overflow dam and reinf. conc. power house at Bullard's Bar, about 40 miles n.e. of Marysville for Yuba Development Co., Hobart Bldg., San Francisco, at $343,654. Dam will be 175 ft. high, 35 ft. thick at base and 6 ft. at top. It will carry a 16-ft. roadway abt. 600 ft. long, similar to that on Devil's Gate at Pasadena.

Cal., So. San Francisco (San Francisco P. O.)—MacDonald & Kahn, 130 Montgomery St., San Francisco, awarded constr. for conc. tank reservoir, 200,000-gal. capy. and 1 mile c.i. pipe, at $40,000.

Que., Montreal—F. G. M. Cape & Co., Ltd., 70 Cathcart St., award. contracts for constr. of reservoir, at $575,000; gate valves and appurts., to Crane Ltd., St. Patrick St.; sluice gate and appurts., to Dominion Bridge Co., Ltd., Lachine; etc.

Ont., York Twp.—Contracts for 6-in. water mains, at $30,000 award., to W. E. Taylor, 22 Falcon st., Toronto, Russica Bros., 256 Ontario, and A. Cavetti, 257 Euclid Ave., Toronto.

Fla., W. Palm Beach—L. C. Hishler, awarded contract for laying and installing pipe line complete for high pressure fire system, at $15,700.

Ill., Maywood—S. B. Geiger, 330 Old Colony Bldg., Chicago, awarded contract for drilling artesian well, at $25,662.

N. D., Valley City—Haggart Constr. Co., Fargo, awarded contract for water mains, reservoir, sewers, etc.; water works, reservoir, etc., $90,581; sewers, $22,653.

Md., Baltimore—O. G. Ligon, awarded contract for digging 3½ mi. ditch for water main of proposed reservoir on Reistertown Rd., at $57,000.

Mich., No. Branch—Pittsburgh-Des Moines Steel Co., Pittsburgh, awarded contract for constr. and installation of water works plant and distributing system, at $28,107.

Minn., No. St. Paul—J. J. Connolly, 1007 Reaney St., St. Paul, award. contract for water works extensions and electrification of pumping plant; 36,000 lin. ft. cast iron pipe, etc., at $50,000.

Mont., Harlem—J. P. Murphy, Great Falls, awarded contract for filtr. plant and 8,000 lin. ft. 6-in. cast iron mains, at $42,680.

N. Y., Raybrook—J. J. Fitzpatrick & Sons, 84 Bridge St., Plattsburg, awarded contract by State Hosp. Comn., Albany, for addn. and alterations to water supply system at N. Y. State Hospital for incipient tuberculosis here, at $19,192.

N. C., Taylorsville—Electrical Constructors Co., Charlotte, N. C., awarded contract for water and sewer systems, also reservoirs, wells and equipt., at $63,418.

Okla., O'Keene—H. H. Dobe, local, awarded contr., at $3,500 for well and power house; Allis-Chalmers Co., Dallas, contract for engine and generator set, at $18,800, and Dwight Chapin, Jr., Wichita, Kans., contr. for elec. distribution and white way, at $15,500.

Okla., Okla. City—Tibbets & Pleasant, Tulsa, awarded contract for purification plant, at $282,700.

Pa., Philadelphia—A. DeSandro & Son, 3906 N. 50th St., awarded contract for laying 6, 8 and 12-in. cast iron pipe, at $31,174; furnishing 6, 8 and 12-in. cast iron pipe to R. D. Wood & Co., 300 Chestnut St., at $64,100; furnishing 6, 8 and 12-in. stop

valves to W. E. Cooney Co., 519 Arch St., at $18,106; furnishing and laying 30-in. steel pipe to A. J. Ellis, 5724 Marshall St., at $21,151.

S. D., Mitchell—Porett & Tuttle, Mitchell, awarded contract for water main extensions, at $34,479.

Tex., Colorado—W. Weeks, Arlington, Tex., awarded contract to complete water works and sewer system, at $32,000.

Tex., Dallas—Hess & Skinner, Engrs., awarded contract thru Myers & Myers, for extending water mains of Highland Park water sys. into Mt. Vernon addn., at $10,000.

Wash., Morton—Auburn Constr. Co., Auburn, awarded contr. for installing Connolly Creek gravity water sys., at $16,000.

Wash., Seattle—Paduano & Co., awarded contract for water mains in Lucile St. et al., at $50,819.

Wis., Blue Mounds—Ayem, Petersen & Rue, Main St., Mt. Horeb, awarded contract for rein. conc. reservoir, laying mains, installing and furnishing equipt. for water works system. Engineer's est. $25,000.

Prospective Work

PROSPECTIVE WORK—ROADS AND STREETS

Cal., Los Angeles—City Engineer Griffin, Los Angeles, is preparing to pave 16 streets in Hollywood dist., west of Hoover Street and no. of Melrose Ave.

Fla., Tampa—Hillsborough County has voted bond issue of $3,000,000 for bldg. 160 miles hard surf. rds. in County.

Ill., Moline—City Council approved Ords. providing for 9 impvts. at est. cost of $237,191. There are 5 paving projects, 3 of which are alleys, one sewer and one water main proj. and 2 big resurfacing projects included in the impvts. Largest of the 9 impvts. is the 17th Ave. paving district, total est. cost of which is $75,587.

Ia., Des Moines—Board of Supvrs. Sac County, have authorized paving 12 additional miles.

Kans., Topeka—Shawnee Co. Commrs. directed A. C. Lagerwall, Co. Engr., to make est. of cost of paving Dover Rd.—Topeka to Wabansee Co. line thru Dover Twp.

Kans., Topeka—Included in fed. aid road allotments, passed by Kans. St. Hwy. Comn., is $325,000 for impvts. and hard surfacing work on Southwest Trail Hwy. from Topeka to Dover—20 miles. It is specified that road shall be built of concrete or macadam. Definite action towards constr. of rd. will be taken in near future. Allowances by St. Hwy. Dept. for roads are: $60,000 appropriation for 1922 for grading and culverts; $145,000 during 1923 for surfacing and bridges and $120,000 during 1924 for surfacing. Total est. cost of road $600,000. Harper Co. has been allotted $105,000 for 7 mi. conc. rd.; Linn Co. $37,500 for bridges on 7.28 mi. no. & west of La Cygne & $21,841 for grading and culvts. same rd.; Allen Co. $31,610 for 7½ mi. conc. Iola-Humboldt Rd.

La., Monroe—It is planned to divide Morehouse Parish into two road districts and call an election in September to vote on $1,100,000 road bond issue.

Miss., Jackson—Approx. $780,000 has been allotted from fed. aid funds by state hwy., connecting St. Augustine, Fla., of Miss. link of Old Spanish Trail trans-continental hwy., connecting St. Augustine, Fla., with San Diego, Cal. Allotment was made to the 3 Counties thru which hwy. runs: Hancock Co., $200,000; Harrison, $200,000, and Jackson, $380,000.

Miss., Winona—State Hwy. Dept. has notified road commrs. here that Montgomery Co. has been allotted $100,000 fed. aid for road constr. in county.

Mo., Jefferson City—Contracts for grading and first work on 1,500 mi. state's good roads program will be let within a month. Dists. will be cut into 5-mile sects.

Mont., Great Falls—Cascade County will build road from Rainbow Falls power plant to Big Falls dam, Volta. F. C. Roosevelt, Co. Clk.

Mont., Havre—E. J. Doreen, Dist. Hwy. Engr., instructed by Bd. of Co. Commrs. to notify State Hwy. Comn. to ask bids for constr. of hwy. proj. 132—Gildford to 1 mile west of Rudyard on Roosevelt trail.

Neb., Lincoln—Plans for following approved by Government: Proj. 42, Sec. B, 5.11 mi. sand clay on Taylor-North Rd.; 87, Sec. A, 2.50 mi. gravel, Norfolk-Stanton Rd.; 88, Sec. B, Oakland-Crowell Rd., 1.10 miles sand-gumbo; 92 S. A., 3.38 mi. earth, Litchfield-Hazard Rd.; 98, S. C., 6.71 mi. earth, Crete-Dorchester Rd.; 139, S. A., Norfolk-Ewing Rd., 3.22 mi. gravel. Plans submitted for approval include 102, Sec. B, Smiley-Canyon Rd., 3.08 mi. earth rd.; 138, B, LaPlatte-Omaha, 8.46 mi. earth rd.; 176, Curtis-Maywood Rd., 5.9 mi. earth; project statement approved on 158, Atkinson-O'Neill Rd., 19 mi. earth; 174, Elm Crk.-Holdredge Rd., 2.8 mi. gravel, also 178, Gilmore-Omaha Rd., 2 mi. earth. Plans being revised on 6.63 miles earth, Springview-Ainsworth Rd., 197.

Okla., Ardmore—Carter Co. Commrs. will construct 11 miles Lee Hwy. connecting with Johnston Co. line, $85,000 pledged by Commrs., expect Fed. Aid for same amt.

Okla., Muskogee—Muskogee Co. Commrs. plan bldg. 17 miles of hwy. bet. Warner and Muskogee-Haskell Co. bridge, now under constr. across Canadian River at Briartown, est. cost $180,000. Commrs. have approved plans for 11 miles hwy. bet. Warner and Webber Falls. Surveys being made for 6 miles rd. east of Ft. Gibson on Ft. Gibson and Tahlequah, Cherokee Co. Rd. Approx. cost $30,000; 3 miles of rd. bet. Muskogee and Spaulding brdg. leading into Wagoner Co., $36,000; 6 miles rd. bet. Boynton, so. to Council Hill, $96,000; 2 mi. hwy. to close gap across Ark. River near Frisco Ry. brdg. in Jefferson Co. Will have both Fed. and State Aid.

Penn., Easton—Northampton Co. Commrs. have acted favorably on application of residents of 4 of the Twps. in northeastern west sect. of Co. to secure 25 mi. new cem. hwy. Est. cost abt. $875,000.

Tex., Austin—U. S. Bureau of Pub. Works, Washington, D. C., has approved bldg. 7.5 mi. St. Hwy. 10, bet. Benbrook and Parker Co. line; gravel surf. with 2-in. bitum. top. Approx. cost $120,500. R. V. Glenn, Co. Engr.; 8-mile, 16-ft. gravel rd., St. Hwy. 3 from LaGrange to boundary line of Precinct 4 in Fayette Co., Fed. Aid Proj. 285, $89,637. A. Schlaffle, Co. Engr.; 14.3 mi. St. Hwy. 6, Dallas Co., FAP. 288; surf. with asph. macadam 18 and 20 ft. wide, $535,000. Nagle, Witt-Rollins, Engrg. Co., Dist. Engrs.; FAP. 304, 8.6 mi. Austin-Fredericksburg Hwy., Travis Co. bet. Oak Hill and Hays Co. line, $36,685; FAP. 302, 5.6 mi. St. Hwy. 3-A. Austin-Bastrop Rd., Travis Co. bet. Onion Crk. and Bastrop Co. line, $18,238, O. Leonard, Co. Engr.; Bowie Co., K. B. Williams, plans 16.8 mi. gravel surf. rd., St. Hwy. 1, Cass Co. line to Rd. Dist. 3 line, $760,500. R. V. Curnutte, Engr.

Tex., Houston—Mayor Holcombe's Impvt. program has been adopted by City Council and more than $400,000 authorized for following impvts.: Graveling streets, $100,000; paving, $122,000; storm sewers, $112,000; san. sewers, $35,000, and storm sewers on 11th St. and Castle Court, $80,000.

Va., Clintwood—Dickinson County Bd. of Supvrs. has $400,000 available for completion of following projects: 10 mi. State Hwy. bet. Fremont and Haysi, $200,000; 8 mi. St. Hwy., Clintwood point up to George's Fork Crk. to Wise Co. line, $150,000; also $50,000 for Hwy. bet. Clintwood and Wise Co. line on rd. to Coeburn.

Va., Richmond—Chrmn. Shirley of Va. Hwy. Comn. has announced that $2,000,000 is now available for hwy. constr. in state. $400,000 appropriation is from Dickinson Co. for use on constr. of 3 hwys. Portsmouth's gift is $34,000 for bldg. 3½ mi. hwy. out of that city; appropriations of $100,000 from Buckingham and $50,000 from town of Halifax were received by the Comn.

Wash., Vancouver—Contract for No. Bank Hwy. —Underwood to Lyle—in which 11 miles new rd. will eliminate 15 mi. present route, will be let early in October. Road will be built with fed. aid and will be graveled.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alverd, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

W. Va., Wayne—Lincoln District, Wayne Co., voted $150,000 bonds for impvt. of roads. Among first projects planned is impvt. of road bet. Marrowbone bridge and Butler line connecting Missouri branch, Dunbar, Ferguson, Radnor and Genoa. Contracts will be let in four separate sections in November.

SEWERAGE AND SEWAGE TREATMENT

Ala., Anniston—City will construct sewer system on various sts. and extend present system to Tyler Hill. So. Anniston to connect with Oxanna.

Ia., New Vienna—Plans under way for sewers and disposal plant. Cons. Engr. Howard B. Green, 634 Cedar Rapids, Savings Bank, Cedar Rapids. Geo. F. Gerken, City Clk.

Ky., Hazard—Plans and specfs. of complete new sewerage system for city being prepared and bids will be requested within 30 days. The J. N. Chester Engrs., Cons. Engrs. Union Bank Bldg., Pittsburgh.

Neb., Grand Island—Plans being prepared for Sewer Dist. 83, Dist. 86, Dist. 85 and Dis. 82. H. E. Clifford, City Clk.

Neb., Lincoln—Will install sewer in San Dist. 1. P. & Q. Sts., bet. State Street and Capital Beach. Est. cost, $9,000. Theo. H. Berg, City Clk.

La., New Orleans—Sewerage and Water Board voted to constr. extension of about 3,650 ft. conc. pipe to replace open drain in Toledano St.—Broad St. to S. Claiborne Ave. Extension will cost approx. $60,000.

Mo., Kansas City—Bd. Pub. Wks. has approved ord. for constr. of Blue Valley sewer comprising 360 separate sewer districts covering abt. 22,000 acres, in natural draing. area; at present time will constr. sewer in no section. $1,750,000.

Mo., St. Louis—Bd. of Pub Service is creating taxing dist., to construct River Des Peres sewer to cost $10,000. Ord. goes before Bd. of Aldermen September 15th.

Mo., Trenton—City plans forming new storm sewer district to drain about 49 acres. Est. cost about $8,080.

O., Canton—Plans being prepared, and specfs., for new addition to sewage disposal plant. $700,000. McClasky & Reese, Canton, Engrs.

O., Marion—$550,000 bonds voted here for constr. of trunk line sewer.

Pa., Jersey Shore—Town contemplates constructing sewage disp. plant. $25,000. Engr. not announced.

Pa., Pottstown—City considering issuing $200,000 bonds for sewerage system and sewage disposal plant.

S. C., Gaffney—Bd. of Public Works will extend 8-in. sewers; 8-in. terra cotta pipe. Construction by city forces.

S. D., Gregory—Citizens voted in favor of constr. of modern sewer system.

Tenn., Knoxville—City has petitioned Legislature for $50,000 for completion of sewer sys. in suburbs of Oakwood and S. Knoxville. L. Herbert Kidd, Engr.

WATER SUPPLY AND PURIFICATION

Ark., Fayetteville—City will extend and renew water system; daily capy. 500,000 gals. E. M. Ratliff, Engr. J. Fulbright.

Ont., Eastview—City will soon receive bids for water mains; cement or cast iron. $54,000. J. C. S. Wolf, Twn. Clk.

Que., Montreal—Metropolitan Comn. soon to ask bids for laying water mains in Montreal North. $160,000.

B. C., Vancouver—Plans being prepared for water extens. to cost $10,000. Mr. Fellowes, City Engr.

Colo., Longmont—City Council has decided to construct new reservoir to increase water supply here. Engr. Bice has submitted complete drawings for the reservoir. Est. cost $50,000.

Ga., Atlanta—City contemplates increasing water works facilities by installation of 5 pumps with total capy. of 100,000,000 gals. daily. Plans call for 2 centrif. pumps for Hemphill water reservoir and 3 15,000,000 gal. pumps for Chattachoochie sta.; cost about $500,000; also approved purchase of three 36-in. valves; one 13-in. valve, one 48-in. valve, cost $10,000.

Ia., Hull—Plans being prepared for 15,000 lin. ft. 4-in. cast iron pipe and appurts. $20,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Engrs.

La., Cedargrove—City will expend $125,000 for water works, $100,000 for sewers, $62,500 for street impvts. and $12,500 for city hall. E. T. Archer & Co., Engrs., Shreveport, La.

La., Covington—City will construct water works and sewers with proceeds of $130,000 5½ per cent bond issue. Robt. Badon, Mayor. L. A. Penand, Twn. Sec.

La., Ponchatoula—City will construct water works and sewer system; vote Sept. 19th on issuance of $130,000 bonds.

Md., Baltimore—City purchased about 175 acres additional land in Baltimore Co. for exten. of Gunpowder sys.; impvts. include high service reservoir, capy. 20,000,000 gals., etc. Plans under constr. Will ask bids in about one month. Wm. A. Megraw, Water Engr., City Hall.

Mass., Fall River—Water Board will make start on linking dead ends of mains of water system. Supt. Moran directed to list amt. of pipe needed for that purpose. Est. cost of impvt., $400,000. Water pipe also ordered laid in Manchester, Slade, Read and Moore Sts. To strengthen weak point in water sys., Board voted to lay 12-in. main in Ray St.—New Boston Rd. to Florence St.

N. Y., Dundee—City plans constr. of water works, including storage reservoir, about 4 miles from here. $15,000. Engineer not selected.

N. Y., Niagara Falls—Plans to enlarge filtr. plant. $300,000. D. G. Fort, 251 2nd St., City Mgr.

O., Cleveland—Formation of san. dist., to take advantage of Cleveland's offer to furnish water supply and sewage disposal service, undertaken by Rocky River, Bay Village, Dover, No. Olmsted and Fairview. Village solicitors will prepare petitions to be presented to respective councils.

O., E. Youngstown—Mahoning Valley Water Co., 403 Mahoning Bank Bldg., Youngstown, plans new booster sta. to supply additional water to large mills. Est. cost $15,000. T. Evans, Supt. Engr. not announced.

Okla., Vinita—City will construct water system; will pipe water from Grand River at Ketchum, 12 miles distant. $297,000 bonds voted.

Ore., Eugene—Plans announced by C. A. McClain, Supt. Pub. Utilities, for bldg. new reservoir at Hendrieks Pk., to supply water for Fairmount Dist. Est. cost bet. $15,000 and $20,000.

S. C., Laurens—$65,000 bonds voted for filtration plant.

S. D., Salem—Will soon take bids for filtr. plant. $15,000. Chenoweth & Rettingbouse, 210 Boyce Greely Bldg., Sioux Falls, Engrs.

Tex., Clarendon—City will improve water works. $75,000 available.

Tex., Denison—City will make water works impvts. D. C. Lipscomb, Engr. $50,000 bonds voted.

Tex., Greeneville—City will improve water system, extend sewer system, improve and extend fire system. $125,000 bonds voted.

Tex., Juarez—City considering installation of water meter system. Clemente Garcia, Supt. of Water Wks.

Tex., Mesquite—City will improve sewer and water system. $60,000 bonds voted.

Tex., Mexia—Three issues of bonds for $175,000 water works, $10,000 incinerator and disposal plant, and $65,000 sewer system, approved by Atty. General's Dept. Also approved City of Lancaster water wks. and san. sewer bonds at $15,000.

Tenn., Bristol—$50,000 bonds voted for impvt. of water sys. L. Q. Gammon, Mayor.

Wis., Tomahawk—Wisc. Valley Impvt. Co., 1st Natl. Bank Bldg., Wausau, will construct rein. conc. and steel reservoir dam, including gravel and earth embankment, by Day Labor, at $100,000.

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Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
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Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
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Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
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Packard Motor Car Co.
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Motor Trucks.
Acme Motor Truck Co.
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Packard Motor Car Co.
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Lewis-Hall Iron Works.
Packard Motor Car Co.
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Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

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Metropolitan Paving Brick Co.
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Warren Bros. Co.

Paving Joint Compound.
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Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
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Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

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E. I. du Pont de Nemours & Co., Inc.

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—Backfillers
—Brass Goods
—Chimneys
—Chloride of Lime
—Chlorinators
—Coal Handling Machinery
—Concrete Hoisting Equipment
—Concrete Tanks
—Condensers
—Conduit Rods
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—Cranes, Traveling
—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
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—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead-Lined
—Pipe, Steel
—Pipe, Wrought Iron
—Pipe, Wooden
—Pitometers
—Pumps, Air Lift
—Pumps, Boiler Feed
—Pumps, Centrifugal
—Pumps, Deep Well
—Pumps, Steam
—Pumps, Trench
—Pumps, Turbine
—Pumping Engines
—Service Boxes
—Soda Ash
—Specials, Cast Iron
—Standpipes
—Steam Boilers
—Steel, Reinforcing
—Sulphate of Alumina
—Tamping Machines
—Tanks, Elevated
—Tapping Machines
—Trench Braces
—Trenching Machines
—Valve Boxes
—Valve Inserters
—Valves, Gates
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—Water Meters
—Water Softening Plants
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—Well Screens
—Well Strainers

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Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

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The Texas Co.
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Good Roads Machinery Co., Inc.

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Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

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Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
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The Texas Co.

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Austin-Western Road Machinery Co., The
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Pioneer Asphalt Co.
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Pawling & Harnischfeger.
Sauerman Bros.

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Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

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Direct Oxidation Process Corp.

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Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Canneiton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

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Stewart, W. H.

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Lufkin Rule Co., The

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Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

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Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

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Austin-Western Road Machinery Co., The

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Lewis-Hall Iron Works.

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Austin-Western Road Machinery Co., The

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The Barrett Co.

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Littleford Brothers.

Tarvia.
The Barrett Co.

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Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

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Austin-Western Road Machinery Co., The

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Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
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Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

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The Hug Co.

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Coldwell-Wilcox Co.
The Flower Company.

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The Refinite Co.

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The Flower Company.
Pennsylvania Salt Mfg. Co.

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Austin-Western Road Machinery Co.

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American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

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The "Big Scene" in Cement Making

The climax in the huge impersonal drama of cement making is the burning of the raw materials in great rotary kilns.

One of the largest kilns, set on end, would be as tall as a 20-story building. A touring car could run through it.

The kilns are steel cylinders lined with fire brick. They rest at a slight angle from the horizontal on heavy rollers, and are driven by steel gears at half a revolution a minute. A medium-sized kiln weighs 275,000 pounds, empty, and has foundations as heavy as for a 10-story building.

Into the upper end of the revolving kilns flow the finely ground materials for cement. There they meet a blast of burning pulverized coal, blown in at high pressure from an 8-inch jet at the opposite end.

Where the materials enter the kiln, the temperature is 1,000 degrees Fahrenheit or more. As they tumble over and over on their 3-hour journey through the kiln in the face of the flame, they rise gradually to a temperature of 2,500 to 3,000 degrees—more heat than is required for almost any other industrial process.

The workman, watching through his peephole in the end of the kiln, must wear smoked glasses. It is like looking at the sun.

And if you speak to him, you must shout close to his ears to be heard above the roar of the flames.

In a big cement plant, there will be a dozen or more of these kilns, roaring and revolving side by side in one great room.

A medium-sized kiln's output is 25 barrels an hour, and in that time 3,500 pounds of coal must be blown into it.

You may have seen the great smoke stacks in rows over a cement plant. There is a stack for every kiln, and four kilns make a medium-sized plant, with 3,000 barrels capacity a day or thereabouts. When you see four of these stacks together, you can know that enough coal or equivalent fuel is being burned in the kilns beneath to supply the electricity for the homes, streets, shops and industries of three ordinary cities of 20,000 inhabitants each.

In a certain town of 12,000 inhabitants there is a 4-kiln plant where the heat lost through the stacks, because of the great temperature and draft required below, would, if it could be captured, supply three times the electric light and power used by all the rest of the town.

Burning cement, costly as it is, is only one of the heavy fuel consuming operations in cement making.

Every ton of cement you buy takes the equivalent of more than half a ton of coal in heat and power to make it—more than 200 lbs., that is, to the barrel of 376 lbs.

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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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—Asphalt Tool Wagon
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—Bins, Portable Stone
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—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
—Heaters, Tar
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—Industrial Track
—Manhole Covers
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—Mixers, Hot
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—Portable Drilling Rigs
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—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

Use Elastite Joint on all jobs

IN bridges, retaining walls, riprap and other construction where it is practically impossible to make poured joints Elastite can be installed as easily as a spacing strip in making a road-joint.

Elastite is the only "sandwich" joint, being a body of tempered asphalt between two layers of felt. It is this unique construction that gives Elastite its peculiar characteristics of compressibility within its own volume and elasticity in any temperature, making it a water-tight and frost-tight joint which does not chip, or flow in hot weather, nor squeeze out of the joint, does not deteriorate in weather or storage, and is as easy to handle as lumber.

Elastite is a proved joint for all concrete work, including levees, reservoirs, walls, ripraping, bridges, flumes, and dams, as well as roads, streets and sidewalks. Elastite is cut to form or any size and thickness and shipped in any quantity from ample stocks carried in seventeen distributing centers. Write for sample and information.

THE PHILIP CAREY COMPANY
40 Wayne Avenue, Lockland, Cincinnati, Ohio

A few Elastite installations

U. S. Marine Corps Roadway, Marine Barracks, Port Royal, S. C.
Utah State Highways
Wisconsin State Highways
New York State Highways
Missouri State Highways
Massachusetts State Highway
Connecticut State Highways
Kansas State Highways
Georgia State Highways
New Municipal Swimming Pool, Johnstown, Pa.
New Sewage Disposal Plant, Milwaukee, Wis.

8-22

THE BEST ARGUMENT for WINTER MAINTENANCE

Don't sit down during the coming winter months to watch your roads go through a period when maintenance is much needed. Too many roads have already suffered this abuse with the inevitable result.

The Andresen Road Repair Outfit
(PATENTED)

Winter maintenance of roads and streets has been made possible by the introduction of the Andresen Road Repair Outfit. This device permits the repair gang to operate during the entire year, and enables them to make durable patches in the most economical manner.

We will be glad to give you complete information. Write now.

LITTLEFORD BROS.
460 E. Pearl Street CINCINNATI, OHIO

Also manufacturers of portable tar and asphalt heaters, asphalt pots, fire wagons, paving tools, etc. Send for circular.

Heltzel Steel Forms
BUILT LIKE A RAILROAD

Illustration at the left shows the perfect alignment secured with **Heltzel** Steel Forms.

This perfect alignment is a result of **Heltzel** Steel Forms being built like a railroad—a rail, a pedestal and a stake—no keys, wedges or clamps. No right or left hand rails.

Line the pedestals, lay the rails and place them on the pedestals by simply fitting the rail groove over the pedestal flange—fits snug and secure—a perfect joint. Write for a copy of the **Heltzel Blue Book** which gives complete details.

The Heltzel Steel Form and Iron Company
WARREN, OHIO

Largest exclusive builders of steel forms for Road, Sidewalk, Curb, Curb-and-Gutter and all types of concrete construction, and Tamping Machines, Heltzel Hand Strikeoff Tamp, Heltzel Rotary Steel Float, and other accessories.

PENNSYLVANIA

TEXACO Asphaltic Concrete on Lackawanna Trail, Pennsylvania State Highway System. Laid in 1919.

Coal!
Iron!
Steel!

These are the names of great staple commodities which we associate with the State of Pennsylvania.

The names of these products alone convey an atmosphere of solidity and strength. They make us visualize enormous furnaces, great mills, mammoth mines. And if we go a step further, we visualize enormous transportation systems made necessary to ship the huge quantities of coal, iron products and steel which Pennsylvania sends forth each year.

AND

TEXACO Sheet Asphalt on Route 82. Work done by Smith Construction Company. (Blast furnace slag used in concrete foundation.)

Pennsylvania has had to provide durable highways not alone leading from great cities like Philadelphia, Pittsburgh, and others, but has had to provide outlets by roadway from the great mining and industrial centers.

TEXACO Asphalt highways have formed an important link in the chain necessary to complete Pennsylvania's road system. TEXACO Asphalt pavements on the great Lackawanna Trail and other main routes speak for themselves in excellence and durability.

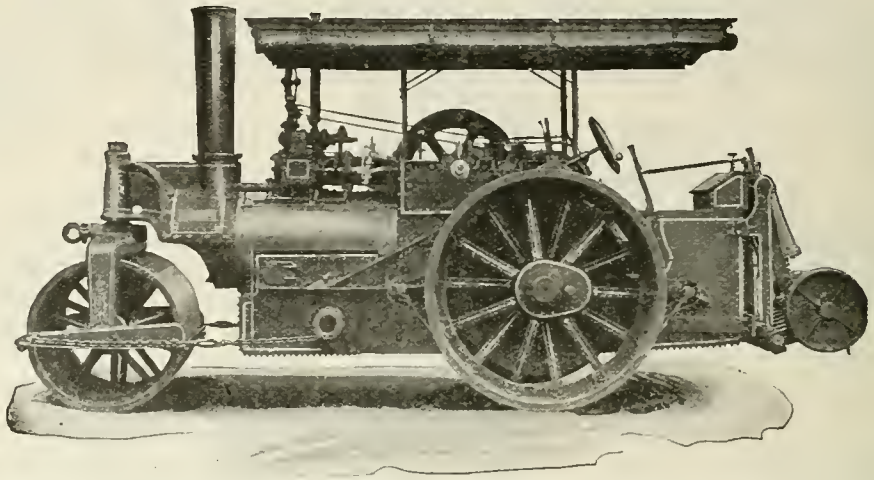
TEXACO

The Texas Company

Asphalt Sales Dept., 17 Battery Place, New York City

New York Houston Richmond Philadelphia Jacksonville Boston New Orleans Atlanta Dallas Chicago Memphis Oklahoma City Cleveland Minneapolis Kansas City

QUALITY ROLLERS



"Buffalo-Pitts" and **"Kelly-Springfield"** render best and longest service. Made in all types and sizes—steam and motor. Buffalo-Springfield Pressure Scarifiers are money-savers and can be furnished with new rollers or attached in the field to rollers already in use.

INQUIRIES INVITED

THE BUFFALO-SPRINGFIELD ROLLER COMPANY

SPRINGFIELD, OHIO

"HIGHLY SATISFACTORY"

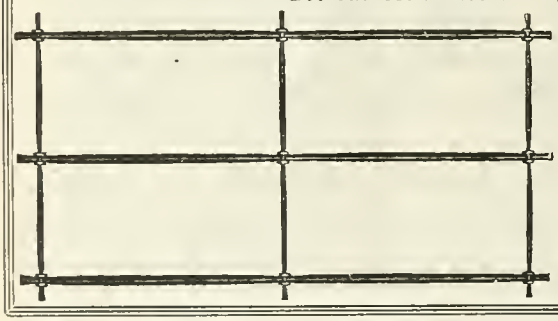
Carey, Campbell & Company write from Naples, N. Y.—"We wish to say that the flat sheets of Mesh Reinforcement furnished by the Truscon Steel Company have proven highly satisfactory. Their shipments have been prompt and their cars well and conveniently loaded, which was quite an advantage in handling it."

TRUSCON WIRE MESH

FOR CONCRETE ROADS

is furnished in flat sheets, saving time and labor on the job. The Truscon Staple Joint makes the connection absolutely rigid. Sheets are cut to any desired length, and a variety of sizes meets all conditions.

Get our estimates on highway reinforcing.



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YOUNGSTOWN, OHIO

Warehouses and Sales Offices in Principal Cities

TRUSCON STEEL CO. TRUSCON HIGHWAY PRODUCTS

TERRIFIC strains throughout a mixer when the charging skip starts! Less strain on the Koehring because the Koehring skip cables get a more perpendicular "pull."

—and the Koehring skip goes to the high charging angle that shoots material into the drum in a swift, clean slide, without need for pounding skip against the frame.

CAPACITIES

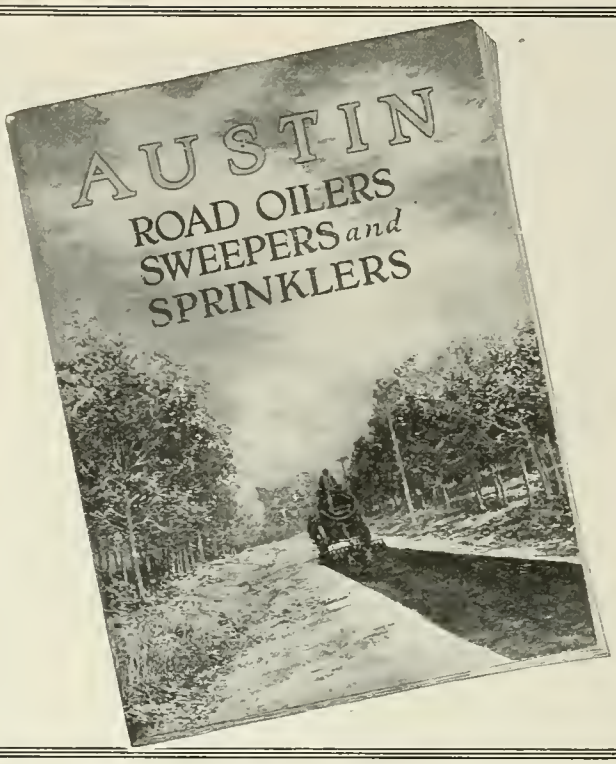
Construction Mixers—10, 14, 21, 28 cu. ft. mixed concrete. Write for Catalog C-10.

Pavers—7, 10, 14, 21, 32 cu. ft. mixed concrete. Write for Catalog P-10.

Dandie—Light mixer; 4 and 7 cu. ft. mixed concrete; power charging skip, or low charging platform; light duty hoist. Write for Catalog D-10.

KOEHRING COMPANY
MILWAUKEE, WIS.

KOEHRING K HEAVY DUTY



A New Catalog

of great interest and real value to all those interested in the most efficient and economical methods of dust laying and road maintenance.

It describes in detail Austin Oilers, Sweepers and Sprinklers in horse-drawn and motor propelled types, together with the complete line of Austin road building and rock crushing machinery. We want to place a copy in the hands of every interested road official and contractor. Write for yours today.

The Austin-Western Road Machinery Co.

Home Office, CHICAGO.
Branchs in 22 Cities.

"Everything from a Drag Scraper to Road Roller."

This is an ideal type of construction for city or town use for several reasons. Usually storm water runs lazily through a town drain pipe because there is not the fall that it is possible to get on a county road. Hence the problem of keeping these drain pipes open is a big one. A 15″ pipe is only about 8″ high, but spreads out right at the bottom to 15″. This allows a full capacity flow right at the start and the smooth flat bottom made of heavy Galvanized sheets doesn't retard the flow of water. Furthermore, the bottom sections are made in 6-foot, 8-foot and 10-foot lengths, which by using separately or combining you can get the short 6-foot length for drainage under sidewalks and any longer length desired in multiples of 2 feet. All top sections come in 2-foot lengths, which is not only a convenient size for handling, but simple to put in or take up whenever necessary. They ship closely nested and take up no space worth mentioning when in storage. Last but not least they are made of 2-ounce spelter-coated "GENUINE OPEN HEARTH IRON" guaranteed 99.875% pure Iron-Copper Alloy.

The Newport Culvert Co., Inc.

425 W. 10th St, Newport, Ky.

A 15-inch Half Round Flat Bottom "Genuine Open Hearth Iron" Culvert.

Electric Light and Power Plant at Miles City, Mont., and two of the 47 buildings now heated by steam that was formerly wasted.

Waste Steam Used for Community Heating

After facts brought out in court showed that Miles City, Montana, was losing more than $100 a day by not selling exhaust steam, permission was given the electric station to proceed with a plan for distributing this waste steam to heat nearby buildings.

A bulletin has been prepared showing the development of this profitable municipal venture. Today, some 47 buildings are heated from the central station plant. Heat sales run over $32,000 a year. Fire hazards are reduced because individual heating plants are thrown out of these buildings. Dirt and dust of coal and ash handling are eliminated. This is one of the four hundred installations of Community Heating designed and installed by our engineers.

If there is an electric light plant or factory in **your** city wasting steam, why not use it to heat nearby buildings? Buy your steam heat as you buy gas or electricity—by meter!

Write for Bulletin No. 20-M E covering Adsco Community Heating of a group of buildings from Central Station Steam Plant. Bulletin No. 158-M E covers Adsco Heating for individual buildings. Architects, engineers and heating dealers should also ask for Bulletin No. 159-M E.

AMERICAN DISTRICT STEAM COMPANY

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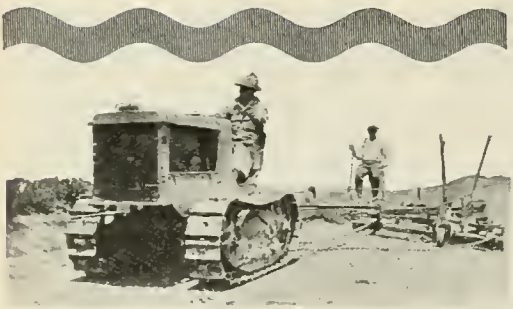
Offices: New York Chicago Seattle

ADSCO HEATING



THE "CATERPILLAR"*

saves money for Dodge City

Dodge City, Kansas, has found the T-35 "Caterpillar"* useful and practical for countless municipal jobs formerly handled at much greater expense by teams. City officials write: "We are glad to report that the T-35 "Caterpillar"* has more than met all of our expectations. This tractor stops at nothing, whether in deep sand or on hard soil, on smooth or rough ground. We are dragging streets at a cost of $8.00 per day, and not only cover more ground, but do much better work than we were formerly able to do with three 4-horse teams costing us $31.50 per day." There are always profitable ways in which the "Caterpillar"* can be employed on city streets, alley, and park work. The city which is "Caterpillar"*-equipped is ready for any emergency demanding power, traction, and real performance in every season of the year. New York, Memphis, Minneapolis, Dallas, Chicago, Detroit, Richmond, are among the hundreds of cities using "Caterpillars"* as the most effective means of handling public works with savings to the taxpayers. Our catalog will interest every public official. Copy sent upon request.

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There is but one "CATERPILLAR"—Holt builds it

PIONEER Highest Quality ASPHALTS

PIONEER Highest Quality ASPHALTS

Filler Asphalt

The ideal brick pavement filler. Made to meet the strictest specifications. Low prices and immediate delivery on any quantity.

"PIONEER"

Every monolithic pavement should have an Expansion Joint. **"Pioneer"** is made from an absolutely pure asphalt, giving maximum expansion and contraction efficiency.

Expansion Joint

THE PIONEER ASPHALT CO.
LAWRENCEVILLE, ILL.

Concrete Roads must be reinforced

It is demonstrated beyond doubt that to make concrete roads proof against heavy motor traffic, weather and time a fabric of steel must be incorporated in the concrete.

Several great States have so ruled.

American Steel and Wire Company's

Concrete Reinforcement

Fulfills every engineering requirement.

Send for our book on road building.

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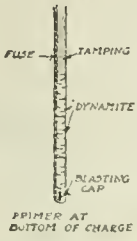
Dynamite Efficiency Depends upon Proper Priming

Load Dynamite the *Wrong* Way and You *Lose* Money

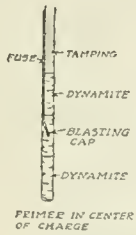


Here is one WRONG way:

For instance, the cap with fuse should not be placed at the bottom of the hole like this as the side spit of the fuse would be likely to set fire to the dynamite.

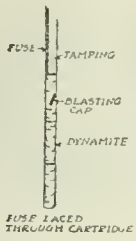
—here is another

This is also bad practice as the cap is pointed *away* from the charge instead of toward it and the fuse is also likely to set fire to the dynamite before the cap explodes.



—and another

Even the middle of the charge is not the right place to put the primer as the top cartridge does not receive the full force of the cap and the fuse may ignite the powder that touches it.



—still another

Lacing the fuse through the priming cartridge is bad practice. It nearly always lets the fuse side spit into the dynamite.

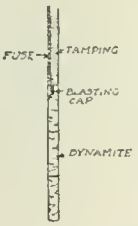
Another WRONG way:

This kind of loading, without tamping, is expensive and inefficient as the top cartridge wastes most of its force blowing out the hole. The Bureau of Mines reports that tamping increases the effectiveness of high explosives enormously

—and another

If the holes are full of water the cartridges of dynamite should not be slit as water affects nearly every kind of dynamite except gelatin.

Load Dynamite the *Right* Way and You *Save* Money



The RIGHT way:

This way, with the cap in the top of the *top* cartridge, pointing *down* toward the bulk of the charge, with lots of tamping and no part of the fuse touching the powder will give you a perfect shot every time.

Another RIGHT way:

Or even if you fire electrically, you will get best results this way as the electric blasting cap is placed so as to exert its *maximum* detonating effect on *all* the explosive in the charge.

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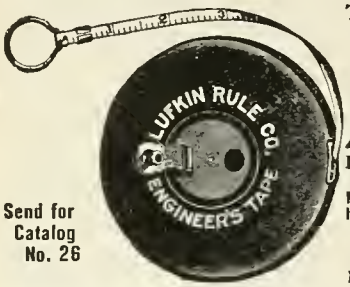
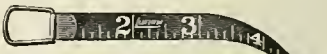


That's what you can rest assured you are getting when you use



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Surpassed by None

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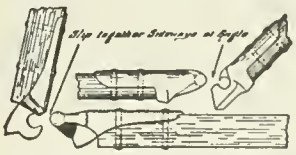
We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also Rods with wheels for conduit work.



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RUST ONLY PROTECTS IT

In cast iron rust never penetrates below the surface; the first layer of oxide which it forms acts as a protection, effectively preventing further corrosion. Should the tar coating placed on all water pipe become destroyed, the metal will, in this way, form its own coating.

For this reason cast iron endures under exacting conditions. The history of cast iron pipe, and it goes back for centuries, has not been long enough to establish a limit.

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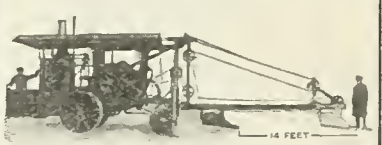

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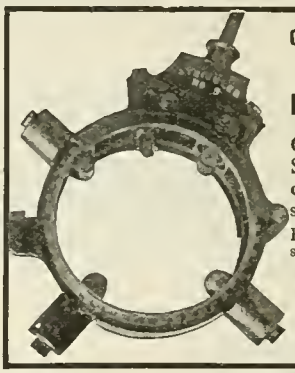

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Each size cuts a range of sizes. Catalog on request.

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EDITORIAL

RECIPROCAL HIGHWAY COURTESY

The courtesy campaign being conducted by the American Automobile Association in connection with the Chicago Automobile Trade Association and the National Automobile Dealers' Association, in cooperation with local motor clubs, is deserving of universal commendation and support. It is expected that motor vehicles throughout the entire country will soon be displaying green and white stickers on windshields bearing the words "Automobile Courtesy," in large letters, over the name of the local motor club. The reciprocal practice of highway courtesy will greatly increase the safety as well as the pleasure of highway travel.

Commenting on the courtesy campaign and its objects, D. H. Lewis, of the American Automobile Association, recently said: "We believe that 50 per cent of the automobile accidents which happen on the highways of the United States could be avoided through the use of a little automobile courtesy. Courtesy costs nothing and brings greater results than any other element entering into the driving of an automobile. Real automobile courtesy demands that we give the other fellow his share of the road; that we dim our lights when meeting another car at night; that we recognize the fact that the man behind us blowing for the road wants to get by and is not challenging us to a race; in short, it means being agreeable in all these little things that go so far toward avoiding friction."

This campaign, to be of greatest use, must include all users of the highway, including cyclists and pedestrians. Often pedestrians swarm and sprawl all over the road, with their backs to traffic, and pay no attention to horn signals to move over, except to say, as the motorist finally gets by: "Aw, go to hell!" or, "You've got a horn, have you?" Such discourtesy is now common, and it is nothing short of miraculous that more pedestrians are not being run down every day. Bicyclists are almost as bad as pedestrians, wabbling all over the road in utter contempt of the rights of other highway users.

There is need for reforms in the practices to which Mr. Lewis calls attention, especially in pulling over to let the man behind get by when he signals his desire to do so. Many motorists seem to regard this as a reflection on their car, if not a personal insult, and either start to race or refuse to give way by so much as an inch. This offense is particularly common in the parts of the country peopled almost exclusively by a very pure strain of old American stock, where the people are drunk on freedom and where every man considers himself an uncrowned king. It is our opinion that an occasional "crowning," say with a pick handle, would greatly improve this class of royalty. But as that isn't being done, now, a courtesy campaign seems the shortest road to reformation.

THE BEST MUNICIPAL ADVERTISEMENT

A well-paved system of streets is the best advertisement the average city can hope to have. Under modern conditions visitors come to a city largely by motor, and their eyes, of necessity, are directed primarily to the pavement. If the pavement looks good and rides well the visiting motorist forms an excellent opinion of the city, but if it looks and rides rough he gets out of town as soon as he can and hopes that he may never have to return.

Sometimes civic bodies spend much money to persuade people to locate in a city. Not long ago a case was noted where such a body, while trying to attract new industries and new citizens, urged a city council to cut its street maintenance budget. Fortunately, the city council appreciated the incongruity of these efforts and the budget was not reduced.

MUNICIPAL

It may be worth while to call attention to the fact that a very considerable number of people mispronounce the word municipal. We do not refer merely to the so-called proletariat, down on the street, but to that presumably higher class that spends its working time in offices. If engineers are excepted, not over half the people the editor meets in business pronounce municipal correctly. Some of the more common variants may be of interest.

Perhaps the most frequently encountered mispronunciation arises from a faulty division into syllables: thus we hear mu'-ni-cipal instead of mu-nic'-i-pal. It will be seen that more than faulty accenting is responsible for this atrocity.

Another rather frequent offense in this connection is "monicipal," the "mon" having the same value (phonetically) as in money. But the ultimate is reached in mu'-ni-cip-i-al. Here, in addition to faulty accenting and syllabifying, an extra i is introduced gratuitously, without cause or provocation, without merit or claim. Contemplation of this form so far paralyzes our faculties that it must be left to our readers to determine whether it should be ascribed to illiteracy or to art.

PUBLISHING TRUCK OPERATING COSTS

Too many truck hauling contracts are being taken at prices so low that the contractor is sure to lose money on the job. He is defeated in advance, and the most he can hope to do, after he realizes the predicament he is in, is to limit the amount of his loss.

Without going too much into detail, it may be said that during the business depression truck sales methods have, in many cases, been made too easy for the buyer. It has happened many times that men of small means and experience have come into possession of trucks and have gone out at once to bid on jobs where they knew little of the cost of the work on which they had to fix a price. We have heard of cases where the contract price was not half the actual cost to the contractor.

Of course, there will always be some losses on contract work of any sort, but one of the best methods of limiting such losses is to make actual costs public. We believe the entire truck industry should join with truck owners in making truck hauling costs widely known through publication. This magazine will be glad to publish authentic cost data on motor trucking.

There are arguments against the course here advocated, and we are familiar with them, having had much experience with the publication of construction costs years ago. But at this stage in the development of the truck industry the arguments favoring the publication of trucking costs outweigh those that may fairly be raised against this policy. It is true that the inexperienced will misuse published cost data, but this is regarded as a lesser evil than the present condition, where the inexperienced possessor of a truck oftentimes lacks even a traditional knowledge of trucking costs.

PUBLIC INTEREST IN TEST ROADS

The fact that motor traffic has, to a considerable degree, made obsolete certain types of roads, has been well understood by the public for several years. Latterly a large section of the public learned that highway engineers scarcely knew which way to turn in building roads with available funds to handle present and prospective traffic. The public took a very reasonable, and a very sympathetic, view of the highway engineer's dilemma. He has been exceedingly fortunate in escaping criticism; he should be careful not to disturb the present attitude of the public with reference to road failures and the responsibility for them. Just now failures are attributed to forces which the engineer does not entirely control; he is absolved from blame and left in a very dignified position.

When the test road idea was taken up by engineers the public took a very lively interest in it. Some of the test roads have, perhaps, been advertised rather too well. Newspaper editors, among others, have worked themselves into a position where they seem to expect a complete answer to the road-making riddle from the results of tests now under way. An interesting illustration of this fact was noted recently. A certain widely-read and highly-regarded weekly newspaper printed an editorial on "Practical Road Building" which was written around one of the test road studies now under way. The two most important daily newspapers in the Middle West reprinted that editorial on the same day. Doubtless other papers ran the same matter. Thus the public is held on the very tiptoe of expectancy with reference to results from these experiments.

Since this is the case, and we feel sure it is, those who are responsible for giving out conclusions based on the performance of these test roads should be very sure of any position they take before the public. Conditions are just right now for the public to accept as established fact what may prove to be nothing more than an erroneous opinion. The public will cling to such fallacies long after they have been recognized as such and abandoned by engineers.

While in entire accord with the objects of test roads, we wish again to advise against drawing sweeping conclusions from inconclusive data merely because the tests have cost a lot of money and because the public expects all the uncertainties to be cleared up forthwith.

Constructing Bituminous Concrete Pavement on Crushed Stone Base on Heavy Traffic Providence-Danielson Pike in Rhode Island.

Use of Gravel and Stone Foundations Effective in Insulating Pavement from Serious Effects of Capillarity in Dense, Impermeable Soils.

By Irving W. Patterson, Mem. Am. Soc. C. E., Chief Engineer, State Board of Public Roads, Room 11 State House, Providence, Rhode Island

One of the most interesting state highway projects in Rhode Island is the reconstruction of the road between Providence and Danielson, Connecticut. Originally this route in Rhode Island was built as waterbound macadam, although the State of Connecticut had not hard-surfaced the road between Danielson and the State line. Co-operation by the State Highway Departments of Connecticut and of Rhode Island has resulted in the building of this route entire so that it will serve as the most direct route from Providence to Hartford, and to other cities in central Connecticut.

Six miles of this route in Rhode Island were reconstructed previous to 1920, and the remaining twelve miles were rebuilt during 1921 and 1922. The work during the last two years is interesting especially because of the use made of local materials and because also of the methods adopted in the design of foundations and drainage.

The use of local materials was considered by the State Highway Department to be very desirable in view of the fact that imported materials would have been very expensive because of the long haul from the nearest railroad. Foundations were constructed of gravel and of stone and the pavement consists of a bituminous

VIEWS ON CONSTRUCTION OF DANIELSON PIKE IN RHODE ISLAND.
Views Show Typical Excavation and the Laying of Bituminous Concrete Pavement.

concrete surface laid upon a crushed stone base. The only material used in large quantity which was not obtained upon the site is the asphalt binder, which was hauled in bulk from asphalt refineries located in Providence.

Unfavorable Subsoil Conditions

The sub-soil conditions for the greater part of the twelve miles rebuilt during the last two years are particularly unfavorable. The waterbound macadam surface of the old road each spring broke up badly under frost action, and parts of the road each spring were impassable except for very light vehicles. Ledges and large boulders are very numerous throughout the section traversed by this road, and submerged bars of ledge were responsible in no small part for the serious effects of frost action. For three miles adjacent to the State line is a high plateau, in general fairly level, so that the run-off is rather poor, and upon which the prevailing subsoil is a yellow, loamy, clay, extremely unstable during thaws in the spring and winter. The macadam road built upon this plateau failed badly under frost action during the first spring after its construction.

Intensive Study of Subsoils

The intensive study of sub-soils was an interesting feature of the design of this road. The land in general is very springy, and springs flowing during a large part of the year in the road gutters were numerous upon the longer hills. The water was intercepted by ditches or by drains, so that the permeable foundations provided are not called upon to carry an appreciable amount of water. Since the subsoil is of very high capillarity, it was considered necessary in addition to ditches and drains to protect the pavement by a layer of very permeable material directly beneath. Stone fill was provided through ledge in all cases because of the necessity for taking care of considerable seepage of water through the seams. Gravel foundations predominated and were used in all cases where the existing material in the sub-grade was particularly unstable. In some cases stone fill was laid upon light gravel foundations so that soft material would not work up through the stone fill and detract ultimately from its effectiveness.

Over the high plateau referred to where the sub-soil conditions are particularly unfavorable and where the land in general is swampy, the grade of the road was raised uniformly 20 ins. above the grade of the old road and the filling was done with coarse, stony gravel of very low capillarity. There was practically no excavation upon this section of the road.

VIEW OF FINISHED BITUMINOUS CONCRETE PAVEMENT ON DANIELSON PIKE IN RHODE ISLAND.

The Local Materials

The quality of the local rock in this section of the State is rather too poor to permit its use with success in a pavement surface. The rock was screened to large sizes for the base course and is well protected from the effect of impact and abrasion by the resilient bituminous concrete surface. A considerable amount of the crushed stone was secured from the crushing of gravel. The gravel in this section is well loaded with boulders and large cobbles and in the crushing and screening processes materials both for the base course and top course were secured in one operation. The gravel did not contain stone enough to supply all of the ma-

terial required for the crushed stone base so that it was found necessary to provide a considerable amount of field and wall stone. Tests of the material in the gravel bank previous to crushing disclosed a deficiency of fine particles. The crushing process changed the character of the gravel very decidedly by the addition of a considerable percentage of fines. The use of a small amount of ground limestone with the screened gravel provided a very satisfactory mineral aggregate for the bituminous concrete top.

A Heavy Traffic Road

It is expected that this route upon its completion will carry a heavy traffic. There is no provision in the Rhode Island law limiting gross weights, axle loadings, and unit tire pressures of highway vehicles, and for that reason very substantial construction upon trunk lines is necessary.

The type of construction adopted upon this route has been found to be very satisfactory provided great attention is given the matter of stabilizing the sub-grade so that the pavement is not seriously injured by frost action. The possibility afforded by this type of construction of using a maximum of local materials and a minimum of imported materials appears to commend its use for projects far removed from railroads.

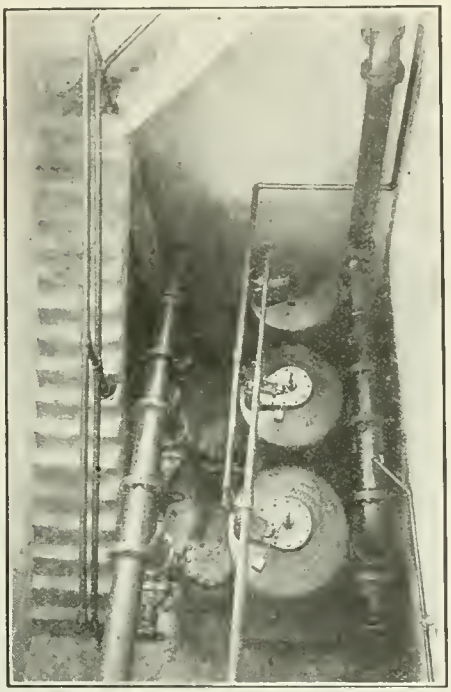
Insulating the pavement from the serious effects of capillarity where dense impermeable soils are encountered by the use of gravel and stone foundations appears to be effective.

BACKWATER FROM KEOKUK DAM DAMAGES FORT MADISON (IA.) SEWER SYSTEM

By L. B. Reynolds, Member of Firm of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

When the Keokuk dam was constructed, the city of Fort Madison, Iowa, located on the Mississippi river 24 miles above Keokuk, realized that not only had the small existing sewer system been damaged by raising the water level, but that facilities for the future sewering of the city had been impaired. In the summer of 1916 the city employed the firm, of which the writer is a member, to make a complete survey of the city and design an adequate sewer system and also determine the additional cost of such a system due to the raised water level in the river. The construction of the system was postponed due to the war, but contract was finally awarded in June, 1920, and construction was completed in August, 1922.

Before the Keokuk dam was built the stage of the river varied up to a maximum of 16 ft., a stage of 12 ft. being normal each spring with an extreme of 16 ft. once in 20 years. For two years after the dam was built the stage averaged 12 ft., but during later years the water level has been held at nearly 16 ft. The Mississippi River Power Co. reconstructed all the existing sewer outlets, raising them to elevation 12, and further offered the city $20,000 in settlement of damages.



VIEW LOOKING DOWN INTO EJECTOR PIT OF SEWAGE PUMPING STATION AT FT. MADISON, IOWA.

The damage caused by the higher river level manifested itself in two ways: first, the actual additional construction cost of the physical system needed to sewer the city, and second, the continual additional cost of operation and maintenance.

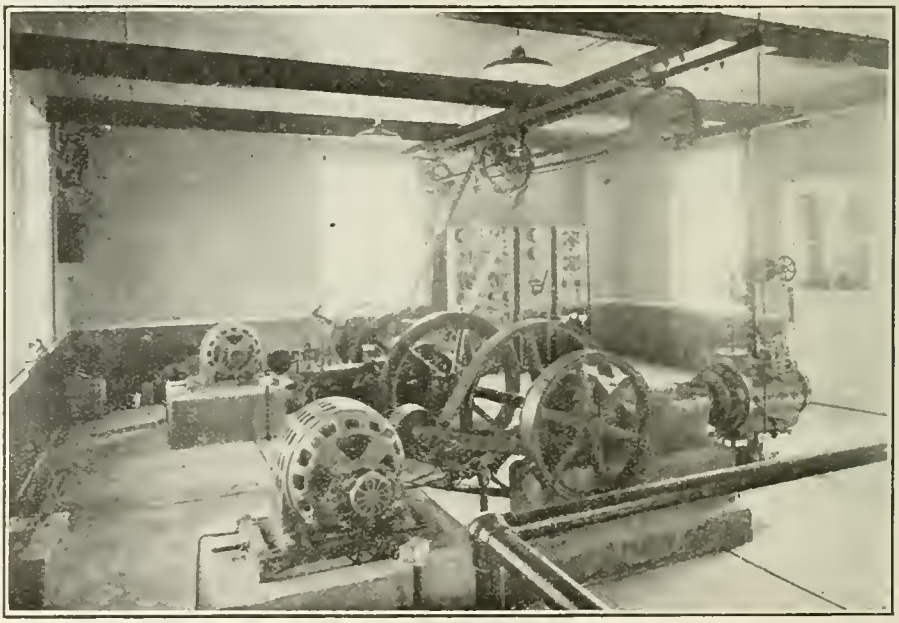
In view of the stage conditions of the river before the construction of the dam, it would have been feasible to plan gravity sewer outlets at elevation 12 and allow the extreme floods once in 20 years to interfere with the system temporarily.

Along the river is a low area which could not be drained by gravity even under these conditions and a small ejector pumping station would have been required to be operated an average of one month per year while the river stage was higher than the sewer outlet. No difference would have been necessary in the system serving the higher portion of the city, but some changes in location, size and grades of lines near the river would have been necessary.

The estimated cost of the proposed adequate system for the city under the conditions existing after the dam was built, less the estimated cost of a properly designed system under the conditions existing before the dam was built, represents the actual damages sustained by the building of the dam as far as first cost is concerned. This additional first cost was determined to be approximately $19,000.

No difference in operation and maintenance costs of the proposed systems before and after the construction of the dam was estimated with the exception of the ejector pumping stations. The head pumped against, as well as the quantity of sewage to be pumped, was much greater after the construction of the dam, consequently, the cost of power required was much greater. The supervision labor required, lubricants, repairs and other operating expenses were estimated and also the depreciation on equipment and the difference in annual charges against the two plants was found to be $2,760. The fund which would produce an annual return of this amount at 4 per cent interest, which was the interest paid by banks on time deposit and paid by the city on its own bonds, amounted to approximately $69,000.

The total damages caused by the raising of the water level due to the Keokuk dam was thus estimated at $88,000, including additional first cost and capitalized extra cost of operation. The damage suit hearing was postponed from time to time and finally in 1921 the Mississippi River Power Co. offered the city $50,000 in cash and the City Council accepted it rather than to incur the costs and suffer the delay of litigation.



VIEW OF MAIN FLOOR OF SEWAGE PUMPING STATION AT FT. MADISON, IOWA, SHOWING AIR COMPRESSING EQUIPMENT.

NOTES ON TWO NEW SEWAGE TREATMENT PROCESSES

By Louis L. Tribus, of Tribus & Massa, Consulting Civil and Hydraulic Engineers, 15 Park Row, New York, N. Y.

When households were served with water drawn in the old oaken bucket, or by the pitcher-pump, the quantity used, except on washday, was very moderate,

so that the old-fashioned cesspool in general, cared for the wastes.

Following the introduction of piped-water into houses, came the abandonment of the outdoor privy, somewhat so, the cesspool, with the construction of sewers as a substitute.

Sewerage systems are of course not alone the product of modern days, for ancient Rome and prior cities, were somewhat provided, but modern plumbing is responsible for the real problems to be solved.

The introduction of sewage into ponds and streams began to create nuisance, and to secure relief, sewage treatment became a new art.

Its early history was little but attempts to separate the solids from the liquid, and to large extent then, only for removal of unsightly and ill-smelling contents: crude sedimentation, rough screening and some slight filtration.

Gradually, sentiment has demanded better results; chemistry and bacteriology have been called in, and now, many methods are successful in practical separation, but few in satisfactory handling of the solids. An effluent can be secured of almost any degree of clarity and even purity, without entailing prohibitive costs.

Separation is but part of the problem, for the solids are generally putrescible, therefore offensive, and, have but a limited field for disposal. The processes that depend upon sludge digestion, to reduce the bulk and transform it to a non-niusance producing product, are bacterial and develop a humus of but slight fertilizing value, taking considerable time in the course of action. At best there is but little market for fertilizer from sewage sludge, or grease when that has been recovered.

Rapid separation through use of some coagulant (usually lime), produces a sludge of somewhat greater value, for it still contains the required elements of putrefaction wanted by certain forms of plant life, and lime which helps a sour soil. A large water content, however, calls for further separation by filtration or presses, or more costly yet, heat drying, while the small proportion of grease is a disadvantage.

Removal of sludge by the more recently popular activated sludge method is quite complete, so far as separation goes, but the water content still is large and not readily removed by ordinary processes.

Many combinations of chemical action have been tried with but scant practical success, yet faith and works will eventually secure the desired ends: viz. the production of fertilizer, where quantity is sufficient and market available at a cost justified by the return, or "land-filling," where such conditions do not obtain.

Two of the recent processes, neither of them as yet very persistently exploited, warrant mentioning, viz:

The McLachlan Process

The "McLachlan," where sulphur is roasted and its fumes passed through the separated sludge, the grease is practically eliminated and a semi-fibrous steadily dried product is obtained. By use of a paper-making type of roller press, the sludge is prepared for immediate bagging, shipment and use, without further treatment. It is claimed that the cost is comparatively slight.

The Selo Process

The "Selo" process takes its name from its four aids, "salt," "electricity," "lime" and "oxygen." When sewage sludge can be dried inexpensively without giving offense, or losing its organic elements, so that later putrefaction can be secured in the ground where plant life can get hold of its ammonia and phosphates, etc., such methods will be adopted, but until then the problem is still with us, unless the McLachlan fills the bill. The Selo makes no such attempt, but tries (and succeeds) to secure rapidly an inert, innocuous, readily hauled, inoffensive humus.

Chlorine is usually considered as a disinfectant, but it is not as chlorine that the good work is done. Strong chlorine added to water causes chemical reactions, producing "nascent oxygen" and "hypochlorite of sodium," both strong so-called "oxydizing" reagents, immediately destructive of all organic and bacterial contents of the water (sewage) to which they have access.

The Selo process calls for separation of liquid from solids; lime being the preferred coagulant to that end. Through the thoroughly akaline effluent, electricity is passed, causing the formation of as much nascent oxygen as needed to attain the degree of purification, (i. e., non-putrescibility), desired. To the settled sludge, low grade, common salt is added, electric current passed through and compressed air blown in to get the agitation needed and supply some oxygen. The salt is broken up and the reagents earlier mentioned, together with caustic soda, produced, completely in one hour of action, destroying all putrescible matter present, and developing a sludge that becomes

hard dry on filter beds in three or four days.

This compares with weeks for the drying of bacterial sludges on sand beds. The final removable material is good only for land fill. Flies, the pest of most sewage works give the Selo process a wide berth.

It is along such lines as these that sanitarians must look for greater advance In solving the sludge problem of sewage treatment. If by-products of value are to be retained, it must be at low cost of production; if not, final disposition must be secured at little expense and no untoward consequences.

There is a nice economic balance between what is worth saving and the cost of so doing; engineers and officials must weigh well therefore these plans when considering sewage treatment and final disposition.

SOLVING MUNICIPAL POWER PROBLEMS IN PARIS, MISSOURI

By F. H. Frauens, Jr., of W. B. Rollins & Co., Consulting Engineers, Railway Exchange Bldg., Kansas City, Mo.

The investigations made for the city of Paris, Missouri, a town of about 1,500 inhabitants, to determine the best method of meeting the necessity of caring for the increasing electric light and power load are interesting for the reason that they covered a period of years and included all possible solutions.

It is too often the case that a city, when confronted with such a problem, does not make any sort of intensive study of the matter, but frequently will purchase some new equipment, rather blindly, without knowing what the results of operation will be, or whether or not some other solution would have offered better or more economical service.

The city of Paris has been operating a steam plant for the past 15 years, the plant consisting at the present time of 2 100 H. P. Scotch Marine Boilers, and one 60 and one 125 H. P. non-condensing Corliss engines, driving single phase 1150 volt alteruators. Early in the year 1920 the difficulty of handling the rapidly increasing load with this equipment was realized, and the city called upon the consulting engineers who had handled all of their improvement work for the past 15 years for advice and estimates of cost of a new plant.

It was found that for the year 1919 the total output had been 162,000 Kw. hours, the fuel cost (coal) of which was 2.43c per Kw. hour, the other operating expenses, including labor, repairs and supplies, being such as to make the total cost of operation 5.02c per Kw. hour.

Proposals to install new steam machinery, an entirely new Diesel oil engine plant, and a transmission line to secure Keokuk power were considered, but as conditions at that time were not favorable for the floating of a bond issue, or for construction work, it was decided to increase the working steam pressure from 100 lbs. to 130 lbs. and to let the old plant run a little longer.

In April, 1922, the matter was again taken up, records for 1921 showing that in that year 264,000 Kw. hours had been produced, or an increase of over 60 per cent in two years. The unit cost of producing this current was 7.06c, this increased cost being due partly to higher prices of coal, but largely to inefficient operation of the overloaded plant. In addition to this higher cost, several breakdowns had occurred to make the service unsatisfactory.

In 1922, five different plans were considered, as follows: A proposition to install two 185 H. P. full Diesel type oil engines, with generators, etc.; a proposition to build a 22 mile, 33,000 volt transmission line to secure current generated by water power at Keokuk, Iowa, and a proposition to build a 16,500 volt transmission line about 25 miles to a neighboring city where current from a central station equipped with steam machinery could be obtained. These three plans would each require that bonds be voted, as the plant would be owned and operated by the municipality. A proposal to allow the company operating the central station 25 miles away to build the transmission line, the city to purchase current at the city limits, was also considered. The fifth plan was the purchase of oil engines of the semi-Diesel type, which could be handled on a lease basis, monthly payments being made to cover the cost, no bond issue being required.

Local conditions had some bearing on the matter, one consideration being that it was thought advisable to keep the bond issue down as low as possible, as a bond election in Missouri requires a two-thirds majority, and the city officials were afraid that a large issue would be defeated.

In addition to the power plant necessary, a new distribution and street lighting system and some water works improvements were required, making the

entire bond issue necessary for a Diesel engine plant about $82,000. It was shown that the saving in operation of the new plant, over the cost with the present steam equipment, would more than provide the funds necessary for the entire bond issue proposed. It is a significant fact, however, that the large majority of citizens do not try to inform themselves about whether or not a matter of this kind is a good business proposition, but base their opposition or approval on snap judgment of the size of the bond issue. It was to overcome this condition that the officials at Paris extended their deliberations over a period of years, and kept the question before the people through the newspapers.

Mass meetings were held on several occasions to discuss the matter and in a further effort to convince the people that the right plan would finally be adopted, Prof. A. C. Lanier, head of the Electrical Engineering Department at the State University was brought to Paris to inspect the old plant, to review the consulting engineers' report and to make his own recommendations. His report, it may be said, agreed practically in all points with the consulting engineers' findings.

Outside of the question of the size of the bond issue, the main consideration was, of course, economy of production. There was not much variation in this item in the various plans, the estimated cost of production per kw. hour, including all costs of operation, maintenance and interest and sinking fund, running from 4.16c to 5.57c, these figures including the operation of the water works system also, it being figured this way because both plants were combined and the water works would need to be operated no matter which plan of securing current was decided upon.

In general, the following angles of each proposition presented themselves. No consideration was given a new steam plant, as it was recognized that a small steam plant could not compare with the other methods proposed. The Diesel engine plant embodied all the advantages of municipal ownership in that it would be located at home and was to be used only to serve its owners. Shipment and storage of fuel oil was not likely to cause any trouble and the fact that the operation of such a plant was efficient and reliable and the cost of producing current low strengthened arguments for this type of plant. The disadvantages were, as stated before, the large bond issue required, and the fact that it has been the experience of all cities that small plants are rapidly outgrown. The plant proposed would consist of duplicate units, each one able to carry a large increase in the present load, but it was felt that in a few years larger engines would be necessary.

The construction of a transmission line to secure power from the Keokuk dam would require a bond issue about $10,000 less than for the plant in town, and while the rates quoted were low, the power to be secured would be 25 cycles, making necessary the construction and operation of a sub-station to change the frequency from 25 to 60 cycles. While the part of the line to be owned by the city of Paris was only 22 miles long, the source of power would be approximately 125 miles away, the other lines being operated by several different companies. A contract could be secured for a period of ten years, and this method would make it reasonably certain that the power demands of the city would be provided for, for that period at least. There was also the chance of selling some neighboring towns an interest in the line.

The 16,500 volt line 25 miles to a neighboring plant would have given service over a relatively short line, and the low voltage would allow the city to serve some farmer connections along the route. The cost of constructing this line would be less than for the 33,000 volt line and sub-station, but the rates quoted for current were considerably higher than those quoted for the Keokuk power. It was also felt that any contract covering rates would be uncertain, as the regulation of these rates would be in the hands of the State Public Service Commission.

The proposition to have the 25 mile, 16,500 volt line constructed by the Power Company would mean that only a bond issue to cover the other work necessary would have been required, but the rates to be paid at the city limits were relatively high. The fact that the city could borrow money by means of a bond issue at lower interest rates than the private company could finance the line also entered into the matter.

No bond issue for anything except the new city distribution system and water works improvements would be required in case oil engines of the semi-Diesel type were purchased, as these engines could be secured on a lease basis, the city

making monthly payments on the equipment. It appeared that the saving in fuel, oil over coal, would be sufficient to meet these payments. The operation of these engines would of course be somewhat more expensive than that of the higher priced Diesel units.

As has been stated above, estimates showed that either one of these five methods would have resulted in enough saving in operation over the old steam plant to cover all expenses incident to the new construction; that is, if the present rates for water and light service were continued, the saving in operation would take care of the operation of the plant and of the bond issue. It was the intention of the city officials fully to investigate each proposition in order to secure the lowest unit cost based on the probable cost of operation and the overhead expense, spread over the probable life of the new construction.

However, before the final decision had been reached, another matter was brought up for discussion, namely, the question of a municipal ice plant. The ice plant question had been discussed at various times in former years, but nothing definite had been done toward securing this necessity. One result of the railroad strike which was in effect during June, July and August, was that for a time no trains were run through Paris, so that the usual shipments of ice were stopped. This caused the question of a municipal ice plant to be considered again, figures on first cost and cost of operation were secured, and it was finally decided to include this item in the proposed bond issue.

The proposed plant would be a 10-ton raw water ice making plant, to be built and operated in connection with the light and water plants. It is probable that the entire output will be sold at the plant, either at retail to citizens, or to a dealer for delivery, most of the supply probably going to the people through the dealer.

A bond issue for improvements as stated above, based on either a municipally owned transmission line or a Diesel engine plant, would have been between $100,000 and $110,000, and it was not thought advisable to submit such an issue to a vote.

This left either the purchase of oil engines on a lease basis, or the granting of a franchise for a privately owned transmission line as the only possible solution. The final decision was in favor of the purchase of two 200 H. P. semi-Diesel oil engine generating units, this decision being reached partly as follows: The main item of expense in the operation of a raw water ice plant is the power required, the monthly consumption during the months when the plant is running continuously being about 22,500 kw. hours. The cost of this current under the proposed contract with the central station would have been slightly over 3 cts. per kw. hr., while it was estimated that the cost to the municipal oil engine plant for the operation of the ice plant would not exceed 1½ cts. per kw. hr. This showed a saving of over $300 per month in favor of the local plant, and was one of the points which determined the final decision.

As the matter now stands, the City of Paris is starting on a program for an oil driven electric light plant to consist of two 200-H.P. units, a new distribution and street lighting system, additional filtration and pumping units, some extensions to the mains, and increased storage capacity for the water works, and an ice plant. The engines and generators will be purchased under a contract calling for monthly payments, these payments being provided by the lower cost of producing current with the new equipment as compared to the cost with the present plant. Funds for the other improvements mentioned will be secured from the sale of bonds.

The final decision of the city officials in this case was made after considerable study of the various points involved, and it is felt that enough facts have been obtained to secure the approval of two-thirds of the citizens for the proposed improvements.

It will be noted from the plans adopted that the principle of municipal ownership of water and light utilities will not only be continued, but extended to include the supply of ice. The light plant at Paris has received excellent support from the citizens, there being only three houses in the city (not counting shanties occupied by some of the colored population) not using electric current, and this in the face of unsatisfactory service in the past, due to the overload carried by the old plant. This support is the natural result of the careful operation of the water and light systems, under the direction of Supt. Geo. C. Blakey, with the support of the city officials.

THE TREND OF MUNICIPAL LEGISLATION AND FINANCE

(Editor's Note: Following is the full text of the report of the Committee on Municipal Legislation and Finance, presented at the annual meeting of the American Society for Municipal Improvements, held at Cleveland, Ohio, Oct. 2-6, 1922. The report was prepared by J. E. Barlow, City Manager, Municipal Building, New London, Conn., as Chairman of the Committee.)

The field which might be embraced in the work of the Committee on Municipal Legislation and Finance is almost unlimited, and any questionnaire of reasonable length, if sent out, would hardly bring forth adequate information. The report, which is herewith submitted, merely directs attention to some phases of the subject coming to the attention of the writer.

Finance

With the advent of the war and its aftermath, practically all cities have had to wrestle with serious financial problems. Some of the contributing factors which either decreased revenue or increased costs may be mentioned, as follows:

(1) Increased cost of labor and materials. For example, the expenditure for grade schools in New London, Conn., has increased in the last five years from $120,500 to $263,100; in the same period the police pay roll has increased from $25,600 to $86,800. The cost of coal for municipal purposes in Dayton, Ohio, increased in two years from $23,000 to $81,000.

(2) Loss of liquor license revenue.

(3) Increased cost of utility and other services furnished to the city. (It is interesting to note that the Legislature in Connecticut has provided financial relief for the street railways at the expense of the cities. The street railways formerly paid for and maintained the paving within car tracks and 24 ins. outside; now the State Legislature has relieved them of this obligation except for an 8-in. strip on each side of each rail.)

(4) The crime wave and epidemic of strikes have increased the burdens on police departments.

(5) There has been a demand for increased service in health and social welfare work, in recreation, parks, for better building codes and stricter enforcement thereof, etc.

(6) Tendency to shorten the hours in the police, fire and other departments. For example, in Dayton the firemen, in pre-war days, had one day off in five; this was changed to one day off in two, or 24 hours on and then 24 hours off duty; this greatly increases the number of men required to man the apparatus. In the same period the pay was increased from $80 to $135 per month. In Cleveland the public even voted an 8-hour day, meaning three complete shifts for the firemen as compared with two in Dayton.

(7) Great increase in motor traffic, both in pleasure vehicles and trucks, resulting in:

(a) Necessity for building more expensive road surfaces and bridges.

(b) Increased maintenance cost of streets.

(c) Increase in cost of handling traffic, necessitating more traffic officers, the maintenance of more traffic signals and the marking of safety and parking zones, the following up of auto thieves, stolen machines, etc.

Methods of Handling Increasing Financial Burdens

Some of the steps taken to meet these increased financial burdens may be mentioned as follows:

(1) Increase in tax rate and increase in the valuation of property.

An example of this is given in the following table, which is for New London, Conn. (population 1910, 18,000, and 1920, 25,000):

Year.	Tax Rate.	Grand Tax List.	Amount Levied.
1915-16	18 mills	$22,191,905	$ 399,454
1916-17	18 mills	25,140,103	452,521
1917-18	18¾ mills	28,649,032	537,169
1918-19	22 mills	29,370,694	646,155
1919-20	26⅞ mills	32,088,511	862,378
1920-21	33¾ mills	33,273,899	1,122,994

From the last column in the above table it will be seen that the amount of money due upon the tax levy of 1920-21 was nearly three times that of 1915.

In some states, as in Ohio, the state raises revenue by a millage levied uniformly upon all the taxable property throughout the state; this works to the advantage of those communities which keep a low valuation on property, with a correspondingly high tax rate. Those cities, on the other hand, such as Cleveland, which more nearly comply with the law requiring full valuation, bear an undue share of state taxation. Thus, if two cities in Ohio raise the same amount of money through the general property tax, but the first does it with half the valuation and hence double the tax rate, the second would have to contribute just twice as much towards the support of the state. This condition, which applies to county levies as well as state, has been no small

factor in defeating the successful operation of the Smith 1 per cent tax limit law in Ohio. In Connecticut, on the other hand, the state collects its revenue from the local taxing units in proportion to the average amount of money collected by each taxing unit during the three preceding years, without regard to tax rates or valuation of property.

(2) Increase in the rates of public utility service owned and operated by the city. In Dayton, the water rates were increased 50 per cent during the war period.

(3) Increase in various licenses and permit fees collected by the city for building permits, for special privileges, etc.

(4) Inauguration of new taxes such as inheritance tax, income tax, special business or occupational tax. Thus, Cincinnati inaugurated an occupational tax in 1919, from which is derived an annual revenue of $500,000.

(5) Increase in registration fees for motor vehicles and returning part of same to the political subdivision where the vehicle is owned. Ohio increased the auto registration fee and returned part of the revenue derived to the political subdivision where the vehicle was owned. Dayton, Ohio, derives a revenue of about $110,000 per year from this source.

(6) Tax on gasoline and sign boards. For example, the state of Connecticut now imposes a tax of 1c per gallon on gasoline; this indirectly relieves cities, as otherwise the state might have to raise more money from local tax on property.

(7) Local license fees for motor vehicles.

(8) Special assessments on property benefited to pay for improvements, instead of paying for same from general taxes. The practice varies widely in different parts of the country. In Ohio the property owner pays 98 per cent of the cost of the street pavement in front of his property, while in Connecticut the general practice is for the entire cost to be paid from general taxes.

(9) Inauguration of more economical administrative methods, centralizing responsibility, the installation of better accounting systems, giving intelligent financial control, the adoption of detailed budgets, the appointment of municipal purchasing agents with requisition system, stores accounts, etc.

Legislation

The progress in municipal legislation in any one year is hardly discernible, so it is necessary to look back over a period of years to discover the tendencies and advancement made.

"Home Rule" for cities, which has been agitated for many years, has, in some instances, been granted in a very large measure by state legislation, as, for example, in Ohio. In drafting new municipal charters, there has been a marked tendency to lessen the number of officials to be voted for. There has likewise been a noticeable endeavor to centralize administrative responsibility.

Initiative, referendum and recall provisions which, only a short time ago, were considered radical theories, are now embodied in many charters and readily accepted. Proportional representation has been included in several charters, noticeably in the new Cleveland charter, which takes effect one year from next January. Direct primaries and non-partisan ballots are now the general thing in new municipal charters.

Many cities have adopted zoning laws, tenement house laws and building laws which a few short years ago would have been considered a transgression on private property rights.

City planning boards have been created with broad general powers and more attention is being given to the orderly development of the city. The scope of the city planning movement has been enlarged and we now have regional plans being developed.

Several cities, including San Francisco, Seattle and Detroit, have extended their municipal ownership activities to include street railways, the ultimate outcome of which will be watched with interest.

There is a growing appreciation of the fact that to conform to a sound financial policy, bonds should not run for a longer period of time than the life of the improvement which its proceeds purchase, and that the bonds should be either serial or sinking fund issues, thus being gradually retired during the life of the improvement. In Ohio this policy has been put into statute form. Under such a plan of financing, the municipality is in effect paying for the improvement as rent, much the same as does the individual who buys and pays for a home through the Building and Loan Association.

In Ohio, and possibly other states, legislation has been enacted which allows the creation of districts, comprising several or parts of several political subdivisions, for the purpose of paying by special assessment for projects which benefit the district and which could not be carried

out by any one of the political subdivisions alone. Thus, a sanitary district for the construction of a sewerage system or a sewage disposal plant can be created to serve several communities. Or, a district can be created to provide protection against floods, as in the Miami Conservancy District, which comprises parts of nine counties, centering at Dayton, Ohio. This latter project will cost approximately $35,000,000, paid for by special assessment upon the property within the district.

James Bryce has forcefully called attention to the fact that the government of our American municipalities was the weakest link in our democracy. However, changes have been taking place gradually. The old town meeting of New England was very democratic, but as the town grew it became unwieldy. Likewise the old complex bicameral form of municipal government, patterned after our Federal government, has seemed, in many instances at least, to have proven unsatisfactory, due partly to lack of centralized responsibility.

After the great storm in Galveston in 1900 the so-called commission form of government came into existence. This combined the legislative and administrative functions in a small elective council consisting usually of five members. When adopted later in Des Moines it was given much publicity and became known as the Des Moines plan. This idea spread rapidly, and in a decade and a half it had been adopted in nearly 300 cities.

The commission plan, however, did not solve the municipal problem. The next general step has been the development of the so-called city manager plan. This is copied from the large private corporate organizations, the small elective council corresponding to the board of directors, and the city manager, appointed by the council, corresponding to the general manager of the corporation. He carries out the entire administrative functions of the city government, the council being the legislative and policy determining body. This plan started in a preliminary way in Staunton, W., Va., in 1908, but gained no momentum until adopted in Dayton in 1913 after the disastrous flood there. It has now been adopted in 287 cities, distributed through 38 states. The most noticeable addition to the list is, of course, Cleveland, with a population of 800,000, where, however, it does not go into actual operation for another year. The other cities in Ohio having this form of government are: Akron, Ashtabula, Cleveland Heights, Dayton, East Cleveland, Gallipolis, Lima, Middletown, Painesville, Sandusky, South Charleston, Springfield, Westerville and Xenia.

The city manager plan of government was discussed at the annual convention of this society ten years ago. There was some sentiment expressed that such discussion bordered on the political, but the writer could hardly be expected to review recent municipal legislation without touching upon this outstanding development.

MODERN WATER FILTRATION PLANT BUILT AT ASHLAND, KENTUCKY

By Donald H. Maxwell, Principal Assistant Engineer, Alvord, Burdick & Howson, Consulting Engineers, Hartford Bldg., Chicago, Ill.

Ashland, Ky. has a population of about 15,000 and is situated on the Ohio River. The city was formerly supplied with water by a private company whose pumping station is located in the adjoining town of Catlettsburg. The Catlettsburg supply is taken from the Ohio River and passed through settling basins before being distributed to the consumers. In 1918, the City of Ashland purchased the water distribution system within the city, and has since then built its own pumping station and filtration plant which is now in successful operation. The new water supply is taken from the Ohio River immediately above government dam No. 29. The filter plant has a rated capacity of 2 2/3 million gallons per day, which it is estimated will provide for the requirements of the city until about 1940.

Cost Kept Down

Owing to the unfavorable conditions of labor and material supply at the time and the anticipated hazards of construction involved in the tunnel and dry well, difficulty was experienced in getting bids at reasonable figures. At the first letting in July, 1919, a single bid on the building construction was received, and this was more than double the engineer's estimated cost. This bid was rejected, and the work readvertised, and a special effort made to interest responsible bidders. This time two bids were received, both of which exceeded the available funds.

It was then decided to curtail the work so that it would fall within the funds available. It was believed that the intakes, low lift pump, pit and coagulation basin could be financed, and their con-

struction would enable the city to supply its consumers with water equal or superior to the Catlettsburg supply and at a much less cost. The work was again readvertised and this time five bids were received. The low bidder at the previous opening again put in the low bid, but although fully half of the work had been eliminated the low bid was only 20 per cent below that for the entire plant. It was evident that the hazard involved in the dry well construction was partly responsible for bids being high.

Cost Plus, Sliding Fee Contract

It was the opinion of the engineer that the bids were still higher than the reasonable cost of the work and the city was advised to assume the risks involved by letting the work on a cost plus sliding fee contract, in which the city's interest was protected by giving the contractor an inducement to economy. Such a contract was drawn up by the engineer in consultation with the Water Board and Joseph E. Nelson & Sons, general contractors, who were awarded the contract and successfully carried out the curtailed work, with a saving to the city of approximately $22,000, or nearly 25 per cent below the low bid. This is the more noteworthy on account of the unusual number of unreasonable freshets in the Ohio River in the fall and winter of 1919-20. These unexpected floods greatly delayed the work and added to the cost. The contract proved mutually satisfactory.

Intakes

Two intakes are provided, at different levels. The dam ordinarily ponds water to a depth of about 15 ft. at the water works, and one intake is located on pile cribbing near shore at a depth of about 2 ft. below normal pool level. This intake consists of a 24-in. W. I. pipe, 10-ft.-6 ins. long, placed lengthwise with the stream, with 1-in. perforations at 2-in. centers. To provide for the contingency of extreme low water at times when the gates of the dam are open, a second suction line is laid on rock below the river bottom and connected by elbows to a 20-in. perforated steel pipe intake 25 ft. long lying on the river bottom and pointing downstream. The perforations are 1-in. holes, 2-in. centers, in the upper half of the pipe only. The perforated pipe is anchored by tie rods and collars to the suction line.

Both suction lines are 20-in. cast iron pipe laid on an up grade to the pumps. The pool level suction line is 200 ft. long and the low water suction line 275 ft. long. For protection and to have the pipes reasonably accessible for repair, both are carried through the steep bank of the river in a reinforced concrete tunnel of horseshoe section, 6 ft. 3½ ins. inside height and 120 ft. long. A manhole large enough to allow of passing a length of 20-in. pipe gives access to the tunnel at the river end, 17 ft. above pool level. The shore end of the tunnel is closed with a water-tight bulkhead through which the suction pipes pass. Access to the tunnel through this bulkhead is provided by an 18x24-in. boiler manhole. The tunnel floor is 6 ins. above pool level and drained to the river through a pipe provided with a gate valve.

Low Lift Pump Pit

The low lift pumps are placed in a circular reinforced concrete pit at the shore end of the intake tunnel with floor 3 ft. above pool level. This pit is 20 ft. in diameter by 44½ ft. deep below the high lift pump room floor, from which access is had by means of an electric elevator and a spiral staircase.

The low lift equipment consists of 3 centrifugal pumps rated at 2½ million gallons per day against 65 ft. total head. Two pumps are motor driven and the third direct-connected to a gasoline engine for reserve service. Very compact arrangement was secured by placing the three pumps in a row and taking suction from a common header of special castings at right angles to the two intake lines. A motor driven priming pump serves also as a sump pump.

Coagulating Basin

The low lift pumps deliver to a mixing chamber which allows for a mixing period of 25 minutes at rated capacity of 2 2/3 million gallons per day. The mixing chamber is an uncovered rectangular compartment at one end of the reinforced concrete coagulation basin and is provided with vertical over-and-under baffles of wood, the passes being 2 ft. by 2 ft. 6 ins. in plan. At rated capacity the maximum velocity through the mixing chamber is 1.4 ft. per second, and the minimum velocity 0.82 ft. per second.

From the mixing chamber the water flows into either of two coagulation basins. These basins provide for 4¾ hours sedimentation at rated capacity of 2 2/3 million gallons per day. Both basins are arranged with central baffle wall, for two passes. The first pass is provided with four 8-in. blowoffs from hopper bottoms sloping 30 degs. to the horizontal. One

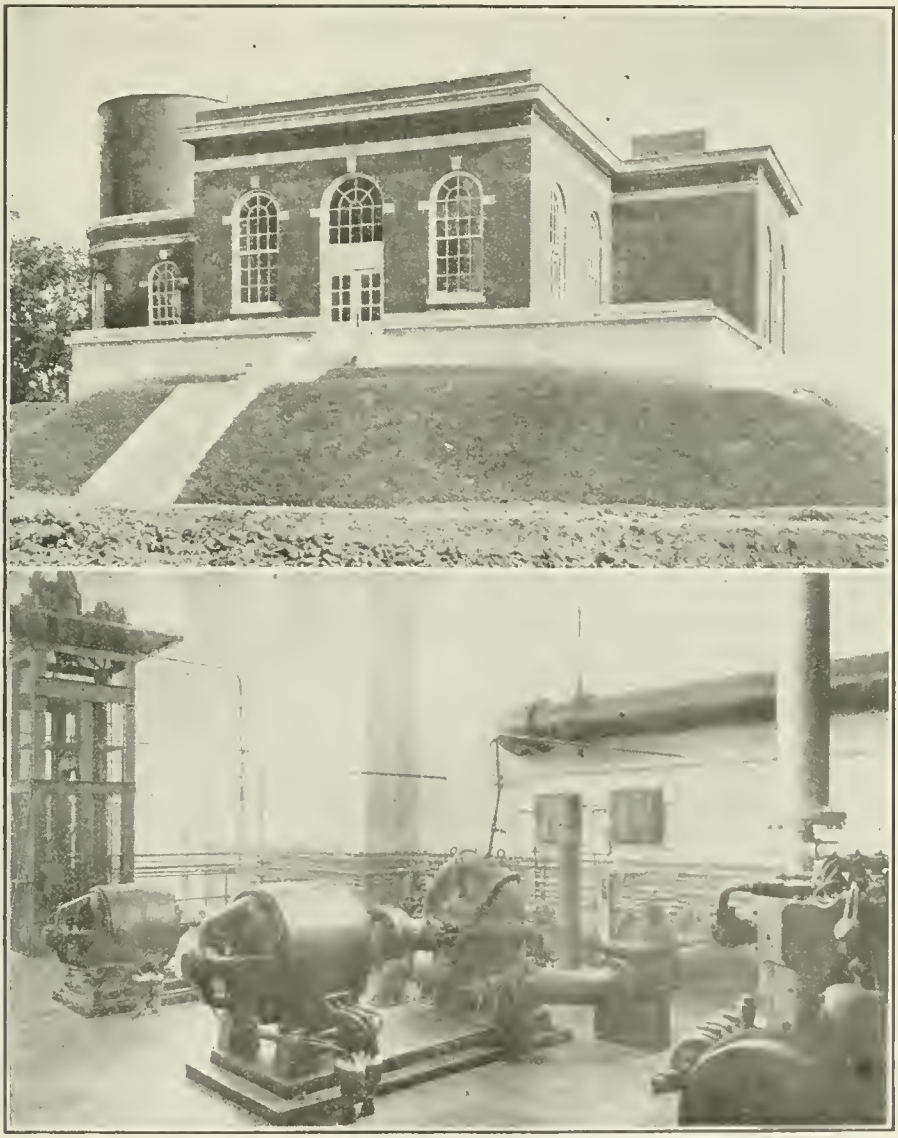
central blowoff is provided in the second pass. Coagulating basins may be operated singly, in parallel, or in series.

Temporary Plant

Part of the high lift pumping equipment was purchased and installed in a temporary wooden enclosure on top of the coagulating basin, and the plant put in operation in the spring of 1920, furnishing the city with water that had been treated with alum, and given approximately eight hours' sedimentation, and chlorinated The results were found to be very satisfactory, and the plant was operated in this manner until the present summer. The quality of the settled water, bacterially, was excellent. The results from the turbidity standpoint were also excellent, even during the floor stages of the river. The water was clear, but lacked the sparkle of filtered water.

Completion of Plant

Additional funds having been provided meantime by bond issue, bids were taken in the fall of 1921 for the completion of the plant. The contract was let to the



VIEWS OF ASHLAND, KY., FILTER PLANT AND INTERIOR OF HIGH LIFT PUMP ROOM.

Ellington-Miller Co., general contractors, for the filter building, and to the International Filter Co. for filter equipment.

High Service Pump Room

The high lift pump room and filter plant are combined in a single structure built on top of a 220,000 gal. clear well, part of the clear well roof forming the pump room floor, through which the suction pipes extend to sumps. The high service pumping equipment consists of two motor driven and one gasoline engine driven centrifugal pumps, the latter being for reserve service. These pumps are of 2½ million gallons per day capacity, and operate against total head of 275 ft. A wash water pump is also located in the high service pump room.

Filter Plant

The four 2/3 million gallon per day filters are over the clear well and arranged in pairs on either side of an operating floor at elevation 557. This floor is about 4 ft. above extreme high water in the river and 13 ft. above pipe gallery and high lift pump room floor. All of the filter building walls, including those which enclose the low lift pump plt, are carried up to the operating floor level. The only opening below this elevatlon is the freight door, which is 9 ft. lower, but this door is provided with a hinged steel bulkhead that can be made water-tight in emergency. The freight floor is also over the clear well and communicates by hand power elevator to the third floor chemical storage room where the mixing tanks are located.

The intermedlate floor, on a level with the filter operating platform, accommodates office, laboratory, lavatory, orifice boxes, venturi meter stand, and from a gallery overlooks the high lift pump room below.

The wash water tank is located on the roof over the low lift pump pit.

The plant was completed and put in operation early in June of this year, under the direction of Mr. W. S. Patton, Water Works Superintendent.

Other Improvements

The water works improvements have been carried out by a Water Commission of which Mr. E. C. Means is chairman. In addition to the new pumping station and filter, a ½ million gallon reinforced concrete reservoir has been added to the system, the old 1½ million gallon reservoir has been roofed over, additional feeder mains have been laid and the existing mains cleaned, putting the plant in first class condition at an approximate cost of $200,000.

Upon the completion of the plant all berms were sodded and the remainder of the station tract of several acres seeded. The trees along the river have been trimmed, slopes graded and the site made a most attractive park.

Cost

The cost of the plant as partially completed in 1919 was as follows:

General contract, including river intakes, tunnel, dry well, coagulation basin and grading	$73,900	
Valves and high service pipe connections	2,025	
Pumps and venturi meter	13,817	
		$88,742
The cost of the deferred work was as follows:		
Filter building, clear well and grading	$35,664	
Wash Water Tank	1,588	
Filter equipment	14,670	
Pumps	3,489	
Piping, moving pumps and miscellaneous	4,158	
Wiring and moving switchboard	1,438	
		$61,007
Total cost completed plant		$149,749

This work was carried out distinctly to the city's advantage in the following respects:

1st. The cost-plus contract on the initial construction, drawn to protect the city's interests, saved the city $22,000 compared with the lowest lump sum bid offered.

2nd. Partial completion of the plant for temporary operation until additional funds could he voted enabled the city to discontinue the purchase of water at an early date, and temporarily (for two years) supply better settled water from its own plant at much less cost.

3rd. Deferring the construction of the filter bullding resulted in this part of the work being let at a very substantial saving, as shown by the following comparison of low bids on filtration equipment, the same hidder in both cases:

Filter equipment, 1919.....$18,300
Filter equipment, 1921..... 14,670

Credit for these savings is largely due to the personnel of the Ashland Board of Water Commissioners. This board is composed of three of Ashland's most successful business men, Mr. Means, the chairman, being an engineer. The commissioners have directed the affairs of the municipal water works in a strictly business-like manner.

The engineering on this work was handled by Alvord, Burdick & Howson, under the personal direction of Mr. L. R. Howson.

FEATURES OF STREET AND SIDEWALK DESIGN IN VARIOUS CITIES

(Editor's Note: Following is the text of the report of the Committee on Street and Sidewalk Design presented at the annual meeting of the American Society for Municipal Improvements. Mr. E. R. Conant, Surveyor of the Department of Highways of the City of Manchester, New Hampshire, was chairman of the committee and Messrs. G. A. Crayton and S. Q. Cannon were the other members.)

In making a study of street and sidewalk design certain fundamental principles are to be considered, the most important being utility, appearance, safety, drainage, and arrangement. That full advantage can be taken of streets and walks sufficient widths should be provided for traffic and crowns and grades provided that will least impede traffic. The relative position of roadways, walks and parkways enter into the utility and appearance feature, and the location of trees, lamp posts, hydrants and poles can be arranged either to mar seriously the appearance of a street or, if the posts, railway poles, etc., are of ornamental design, and properly located, they with the trees or shrubbery can add to the general appearance. The type of curbing and method of laying it adds or detracts from the general appearance. The safety features require consideration of safety islands or zones. For foot traffic the elevation of the curb at crossings should be properly adjusted and with the present fast moving traffic proper curvature of the curb at corners is required. So that surface water upon the streets can be properly taken care of, the arrangement and type of catch basins or inlets is important. Again the arrangement and layout of roadways, sidewalks and grass plats should be considered with a view of widening the travelled roadway area if found necessary to accommodate increasing traffic.

It might be said that only of comparatively recent date has the subject of street and sidewalk design been attempted in a scientific manner, for comparing the data received in our answers to the questionnaire sent out by the committee, it is noted that with the exception of recent layouts in the older cities, street design in them is far behind that followed in the newer cities. Not long ago comparatively narrow streets were suitable for horse drawn vehicles and with the introduction of street car lines, space had to be provided for them, but not until the automobiles came into existence did the engineers and municipal authorities realize that the laying out of streets to care for motor traffic was a real engineering problem that had to be treated in a scientific manner.

It is not at all improbable that surface street car lines, except under certain conditions, will to a very large extent, in the near future, be eliminated, and a new method of transportation will arise which will utilize some type of motor bus and undoubtedly new requirements for roadway area will then be required. Today there are cities and towns located between large cities, between which there is a very heavy truck traffic, which are forced not only to design and adopt types of streets for their local needs, but also to provide for the through traffic. We recognize the fact that types of thoroughfares for a residential city may differ from those required for a mill or manufacturing city. Again, topography enters into the design of our streets so that it is very difficult, if not impossible, to recommend fixed types of thoroughfares that may be wholly standardized but from the answers received from 60 odd municipalities a very good idea is obtained of the best practice now in vogue and this report attempts to give a brief summary covering various features of street and sidewalk design for various parts of the United States and Canada.

Methods for Determining Widths of Roadways

Considering design of streets upon what basis can we determine the proper and necessary width for the traveled roadway? Replies to this question from officials of municipalities show conclusively that the width of roadways should be based on the number of lines of traffic which they must accommodate and while but a very few cities report that they give consideration to the density of traffic as an aid in establishing the necessary number of lanes, but instead generally allow certain widths for each line of traffic, yet the committee feels that a study of the present and prospective amount of traffic is very important and urges that more study be made of this particular feature in establishing present and prospective needs for vehicular traffic.

Widths of Lanes of Traffic

Analysis of the replies received would indicate that for each line or lane of traffic a width of from 7 to 8 ft. is necessary for motor vehicles parked at the curb and from 8 to 10 ft. for vehicles moving.

The greater width is for truck traffic, the lesser for automobiles so that for industrial or business sections a somewhat greater average width should be adopted for each lane of traffic than for the residential section. A reasonable width for each moving lane of traffic should be not less than 9 ft. and at this time it need not be above 10 ft. For parking vehicles 8 ft. is ample. Space for street car tracks should be from 8 to 9 ft. for single track and from 18 to 20 ft. for double track.

Widths of Roadway

With the intensity and character of traffic known the total required width of the traveled roadway is readily ascertained. It is observed that the newer cities of the West, South and Canada have generally wider thoroughfares than are found in the older cities. For streets where two lanes of traffic are required, the width of 18 to 20 ft. is pretty well established. For three lanes of traffic 27 ft., for four lanes of traffic 36 ft., and where a single track exists 10 ft. is allowed and for a double track, 10 to 20 ft.

In the larger cities radial and main thoroughfares should be provided for and generally the distance between these main thoroughfares for residential sections should be from 1,500 to 2,500 ft. apart and for industrial and business sections they can advantageously be laid out for 600 to 800 ft. apart, this spacing being the practice carried out in the cities from which the committee received answers to their questionnaire.

Lanes or Back Streets

Lanes or back streets are of much importance and directly enter into the utility feature. With a system of lanes, especially with a city laid out with the rectangular system, lanes are of special value. The sanitary sewers can be placed in them. Many of the unsightly poles from the street are placed in the back streets, deliveries to residences can be made, and collection of garbage and rubbish as well. Garages constructed on the back of lots can be entered from back streets much better than from the front. The widths of these back streets or lanes should not be less than 18 ft. and preferably from 20 to 22 ft. for for they must accommodate two lanes of traffic and provide space for poles.

Classification of Streets

Classification of streets in some instances are spoken of as major, secondary and minor streets, in other cases as boulevards,main and minor system and lanes. When it comes to considering boulevards local conditions and topography enter into each individual case and where extensive boulevards are planned, the lanscape gardener should be a party with the engineer to lay it out. Your committee does not attempt at this time to standardize the layout of boulevards.

Sidewalks

There must be considered the proper width for foot traffic. Sidewalks in many instances in the past have been laid out irrespective of actual or future needs. The width of sidewalks should be determined by the intensity of traffic, and, from the replies received, the best practice at this time is to adopt a width of from 5 to 6 ft. for residential sections, and from 10 to 15 ft. or more for business sections, the widest walks being called for in the retail business section. The width for walks through parkways or boulevards are often laid out for appearance as well as to meet actual needs, and the widths noted above are not applicable to these conditions.

Grass Plats

The introductions of grass plats or parking space, especially for residential sections, is highly important. Not only does this space offer a suitable location for trees, poles and hydrants, but also enters into the general appearance of the highway and also affords an opportunity, when properly laid out, to permit of widening of the traveled roadway without the acquisition of additional land. The width of a plat where trees are planted should not be less than 5 ft., and the maximum width is fixed for local conditions and by the width of the right of way.

In laying out sidewalks and grass plats a number of cities allot from 1 to 2 ft. on unoccupied space between the sidewalk and the property line when the grass plat is next to the curb. In a minority of the cities from which data have been obtained, the sidewalk is placed next to the curb, and the area between the sidewalk and the property line alloted grass plats. This is with a view, in some instances, of prospective widening of the roadway.

Planning of Streets, Thoroughfares and Lanes

The general layout of streets, lanes and main thoroughfares is a study for Planning Boards or Commissions and is more for the City Planning Committee to report upon than Committee on Street Design. After the streets or their general location are laid out, the width that should be required is for our Committee to study and, as noted above, this study should be based upon the amount of pres-

ent and prospective traffic to be accommodated. In many cities widths of streets are determined by ordinance, some of which are of long standing and the dedication of the streets fix the widths without any regard to the amount of traffic which they will be required to accommodate.

Safety Zones

The general practice is to paint the pavement with lines which designate the area or zones where vehicular traffic must give way and look out for foot traffic. These lines may mark zones where street cars stop or they may mark crossings for foot traffic from one sidewalk to the other. The zones where street cars are approached are usually 6 ft. in width and of proper lengths, and a safety walk from the middle of the zone to the sidewalk on the side of the street where the zone is marked off is advantageous. In a number of cities a raised area way is constructed either by a plank platform about 4 ins. high or a platform of concrete. In other localities posts or stands connected with ropes are installed. However, the question of safety islands or zones is a somewhat mooted one, and at this time there appears to be no general practice. In a majority of cases the zones or islands are marked with paint, and in at least one state, and perhaps others, laws have been passed requiring safety zones, under certain conditions, to be 7 ft. in width.

Sidewalk Crossings

There is a tendency to get away from the step at the curb to the street at street intersections, especially where the foot traffic is heavy. In the replies received there were one or two instances cited where the reverse is reported. The method followed out is to have either a gutter underneath a flagging or iron plates with the pavement brought up with a warped surface to meet the curb grade. Another is to have the inlets to catch basins on each side of the corner and the pavement brought up solid to the curb. Where steps are provided, the height or maximum drop should not exceed 6 ins.

Radii of Curb at Street Corners

Before the introduction of the automobile and motor trucks, when vehicular traffic was carried on with a much lower speed, a 6, or at most 8, ft. radius curb was considered adequate. Under present conditions in new layouts the radius of the curb in residential sections should not be less than 10 ft. In business sections, from 10 ft. to whatever limit can be introduced, according to width of sidewalk and roadway. For alleys, 5 to 6 ft. radius is sufficient. Some cities have established the radii as being equal to the width of sidewalk at the street intersections, and where the width of sidewalks is greater on one side than on the other, the maximum width would be taken by determining the adopted radius of the curb. Other cities regulate the radius of the curb by the width of the roadway, the narrower streets calling for a greater radius than wider thoroughfares.

Catchbasin Inlets

Catchbasins should be connected directly to sewer through manholes; that is, an individual pipe should be carried to the manhole from each catchbasin or inlet, and they should never be connected direct to the sewer except at manholes. They are generally located at street intersections, but where necessary to increase the number, intermediate inlets may be located in the middle of the block. One reply received from Winnipeg states that the catchbasin inlets are almost entirely located in the center of the block, the grades of the streets being flat. The gutters run to the center of the block and pavement at street intersections is leveled with the sidewalk. The older systems of conducting water from the gutter into the catchbasin was to have gratings in the gutter and perhaps a small opening cut in the curb. Every engineer knows these gratings are a nuisance in that they are continually being clogged up, and many an overflow has been caused by their becoming unserviceable, due to leaves and trash clogging the small openings in the grate bars. Modern practice provides for the entrance of the water into the catchbasin through openings either cut out of the curb, or, better, through openings in castings set in the sidewalk, flush with the curb, under which the catchbasin is constructed, and at street intersections there is no reason why more than one catchbasin should be carried from the gutter on either side to the one catchbasin, and with the latter plan the cross-walk for pedestrians can be brought to the level of the curb at the corner. Many cities have the catchbasins located at the center of the curb radius. In some cases they are placed on the property line back of the sidewalk, but neither plan appears as favorable as to have the catchbasins located back of the end of the curb radii.

Crown of Streets

The proper amount of crown is dependent upon the grade, width and character of paving, and to some extent upon the method of providing for run-off of water in gutters. Generally the grade varies di-

rectly with the width and inversely as the function of the grade of the street. A quite general practice is to fix the crown from 1/60 to 1/100 of the width, depending on the grade and character of service, and from the replies received from one or two of the larger cities, the crown is frequently the width of the street divided by 60, less 1 in. Again, in one of the prominent cities the crown expressed in hundredths of a foot is 1½ times the width of the roadway. Other formulas noted is to allow ⅜ in. per foot for one-half the width of street, also 1 in. for each 5 ft. of width.

Analyzing the answers in our questionnaire as regards the amount of crown, the following appears to be the general practice where grades of streets are normal and where the surfacing of the pavement is concrete, brick, bituminous or surfacing of light nature:

For street width of
20 to 22 ft., the amount of crown 4 ins.
24 to 28 ft., the amount of crown 5 ins.
30 ft., the amount of crown 5½ ins.
32 to 42 ft., the amount of crown 6 ins.
45 ft., the amount of crown 7 ins.
48 to 52 ft., the amount of crown 8 ins.

For rough-surfaced streets such as granite block the crown should be increased from 20 to 25 per cent; for macadam or gravel, 50 to 75 per cent, and where the grades of the street exceed 4 per cent the amount of the crown can be reduced in proportion to the grade, from 20 to 40 per cent.

Gutters

Where very flat grades are encountered the slope of the gutter is often made much steeper than the general crown of the street, and in a number of instances cited the slope or rake for the gutter may be as heavy as 1 to 3 ins. to the foot. This prevents pools of water extending out in the street from the gutter, which might occur if the uniform crown of the street was carried to the curb, and especially where there may be slight inequalities in constructing the street surface. Again, a little increase in longitudinal grade or slope in a flat street can be brought about by having this gutter slightly deeper at the catchbasin than it is in the middle or end of the block.

Arrangements of the Roadway, Sidewalks and Park Space with a View of Prospective Widening of Roadway

Special instances can be cited, but undoubtedly the best plan followed is where the municipalities have a Planning Board or Commission, who, with the City Engineer, or other official having charge of the highways, co-operate and have such laws and ordinances passed that permits only the laying out of new streets and thoroughfares based upon a plan that not only will accommodate present traffic, but provides for future growth. In many municipalities such laws and regulations are in force which fix the building line back from the street line, so that if the necessity for street widening occurs, it can be done by acquiring additional land, but not requiring the removal, or setting back, of buildings. Not only is it necessary for the municipalities to have control of the layout of streets within the city limits, but it is very well to have a law which will enable the city to have control of the layout of streets as developed by real estate agents and land promoters within a certain defined distance outside the city limits, this being done for the reason that, as the city limits are extended, there will be a regularity and proper uniformity of layout that will conform to the city's street extensions when the limits are extended.

The arrangement of parking space and sidewalks can be so carried out that in case the roadway requires widening, the extra width can be taken from the park or sidewalk space. One instance where a paved street was widened without changing the crown or tearing up any of the pavement, and yet not increasing the depth at the curb, is of interest.

The paving at the new curb line was started at the regular height or distance below the top of the curb and sloped to the edge of the old pavement, making a gutter several feet from the edge of the curb. Before this was done it was thought by some that the method would be undesirable, but it worked out so successfully that a number of streets in the same city were widened in this manner. This method appears rather novel, but might be used in special cases.

Location of Lamp Posts, Poles and Hydrants

In many cases poles, hydrants or posts are set just back of the curb, but a better practice would be to have them set back from the curb a sufficient distance so that vehicles in parking will not hit them. We know that some automobiles have overhanging tops, and when parking upon streets with considerable crown, there is danger of hitting posts or poles if they are not set back a little distance from the curb. This need not be more than 1 or 2 ft. Where park space or grass plats exist,

lamp stands or posts are generally set in the middle of the grass plat.

In conclusion, the committee feels that a start has been made in ascertaining what appears to be the most modern and best practice as regards street and sidewalk design.

VALUE OF PRESENT TESTS FOR GRANITE IN DETERMINING PROBABLE WEAR IN PAVEMENTS

By Clarence D. Pollock, Consulting Engineer, Park Row Bldg., New York, N. Y.

In studying the present tests for granite in determining its suitability for paving blocks it may be well to study the history and development of these tests.

At first no tests were made, but the blocks were cut, paved and simply submitted to the service test. Architects had required the test for crushing strength of granite which was to be used in building construction. Some of the engineers thought that a test should be called for and knowing of the architects' test, they inserted this in the specifications. Various minimum requirements were used, varying from 15,000 lbs. per sq. in. up to even 30,000 lbs. per sq. in. When the minimum requirement was much over 15,000 lbs. it was found that many granites which had proved very satisfactory under the service test for long periods were barred out. A study showed that no very definite relation could be found between this test and the behavior of the granites under the actual traffic conditions. In 1915 the American Society for Municipal Improvements adopted specifications with tests for impact or toughness and the abrasion test for French coefficient of wear including minimum requirements for moderately heavy traffic and heavy traffic.

Impact and Abrasion Tests

At that time these tests seemed about as fair as any which had been tried, although they were not devised for this purpose. Since then, from observation of results obtained in laboratories and results in the pavements, it has been difficult to find much relation between these tests and the actual service test in the streets.

These two tests were designed to measure the relative resistance to impact and wear of broken stone for use in macadam road pavements, and they do not fit in with the conditions surrounding the use as paving blocks, to any great degree.

More Practical Tests Needed

The object of this paper is not to advocate the abandoning of all tests, but to encourage experimental study for the developing of more practical tests by calling attention to the defects of those now used in the testing of granite for paving blocks.

In the toughness test the sample is very small, 1 in. diameter and 1 in. high, and great care is necessary in making the sample or there will be wide variation in results. A little carelessness in making the test specimens from the same sample may result in an error equivalent to 25 per cent of the total range of all granites used in the Eastern portion of the United States. This chance for error detracts greatly from the value of the toughness test aside from the fact that it is a test that does not approximate the wear conditions in the street.

High Probable Errors in Present Tests

In the test for French coefficient of wear, also, the error may be as great as 25 per cent of the total range of the granites, due to the method usually used in breaking the test pieces with a hammer, which may start incipient fractures and also because of the irregularity of the shapes of the pieces for the test.

Machine-Made Test Pieces

The Bureau of Public Roads has developed a machine for breaking out the test pieces by pressure, which obviates the fault of incipient fractures and produces more regular shapes, but this cuts down the range of results on the various granites and makes it more difficult to differentiate the various granites.

This test does, however, show whether there is any real disintegration or not. The old idea that discoloration indicated disintegration has been thoroughly exploded. Discolored or "sap" stone may in many cases show a greater strength than the clear stock from the same quarry. Real disintegration will show up in this test and herein lies its chief value in giving the relative strength of the material from the same quarry, although it is not of much value beyond this in indicating how it will wear when paved in the street.

Improving Test for French Coefficient of Wear

With the object of improving the present test for French coefficient of wear for granite block pavements, the laboratory of the Bureau of Public Roads has made modifications in the methods of preparing the test pieces for the Deval abrasion test as previously stated, the samples being broken into small cubical blocks by means

of a machine instead of by hand. The machine consists of a 20-ton forcing press such as is used in automobile repair shops for forcing the gears from shafts. This press is equipped with both stationary and movable knife edges and it has sufficient power to break a standard 5-in. granite block. This machine breaks the block into small cubes rapidly and much more accurately than can be done by hand and in addition avoids the danger of starting incipient cracks in the stone. In other words, the test pieces have good, clean, fairly regular faces and are approximate cubes.

Abrasion tests upon these fragments showed a greater coefficient of wear than the old method, but the results checked much better, although the range in values obtained with the different granites was much more limited than with the hand-broken specimens. In order to increase this range, Mr. Jackson tried a modification of the abrasion test which was proposed by Messrs. Scofield, Mattimore and others, as follows: A number of longitudinal slots 1/16 in. each in width were milled in the abrasion cylinder, and the test was run on granite from 12 representative quarries, making 2 to 3 tests on each kind of granite. Tests were also run on these same granites, using the present method, and the results were compared. The elimination of the dust cushion gave lower coefficients of wear but the maximum variation of check tests was much less. In general, the coefficients of wear were somewhat over 2 points lower than with the present standard apparatus.

The total number of tests made was not sufficient to draw definite conclusions as to what minimum coefficient should be specified, but the maximum variation in check tests was sufficiently low to indicate that this was a step in the right direction. It is urged that more tests be made along this line and if they prove as consistent as those already made by the Bureau of Public Roads and several other laboratories, it may be possible to select definite minimum requirements to be used with these modifications in this test, which will be an improvement on the present standard, so that this test may be much more satisfactory than at present. This test is valuable as a means of proving whether a granite is disintegrated to any extent or not.

Accelerated Traffic Test

Several years ago the Bureau of Public Roads constructed 19 sample sections of granite block pavement from different quarries, using different forms of filler and cushion and tested them by an accelerated traffic test, which consisted of a machine having a frame carried upon rails which were parallel and on either either side of the sample sections of pavement. These rails were supported firmly by concrete stringer or beams, which also formed the sides of the pavement sections being tested. The subgrade was natural earth on a side hill having a gentle slope. Upon the subgrade, 18 ins. of rammed cinders were placed and then 8 ins. of Portland cement concrete was deposited. On this foundation was constructed the various cushions and the test sections of granite pavement. In the frame of the testing machine were cast iron discs having a diameter of 4 ft., which ran freely in the frame. This frame was drawn back and forth over the test sections by means of a cable. This is the nearest approach to a service test which has yet been devised. However, it was not possible to draw very definite conclusions from the results obtained, as there was more or less settlement of the concrete foundation, probably due to the large amount of cinders underneath it, and the narrowness of the pavement between the concrete foundations of the rails. It would seem as though some such form of practical test could be devised which would not be so cumbersome or expensive but that the laboratories could afford to use it.

An important point to be borne in mind in devising a better test is not so much how individual blocks will act under the test as how they will act when combined, as in a pavement with the usual joint spacing and the different fillers in the joints.

A simple form of accelerated traffic test would be the ideal one and approximations of this are what should be aimed at in securing a more practical test.

Only One Present Laboratory Test of Any Value

In summing up the value of the laboratory tests now used to determine the wear of granites in granite block pavements, the conclusion is reached that the test for French coefficient of wear is the only one of value and the principal advantage of this is to determine if disintegration has progressed sufficiently to render the stone unsuitable for use in pavements, provided the coefficient of the normal clear stock of that quarry is known. The value of this test will probably be increased by using the modifications as were tried by the U. S. Bureau of Public Roads.

In the test for abrasion it would be advantageous to use the percentage of wear directly rather than the French coefficient, as in the lower percentages of wear the French coefficients change greatly for small percentage changes.

The foregoing paper by Mr. Pollock was presented at the recent annual meeting of the American Society for Municipal Improvements.

HOOVER ON THE PUBLIC AND THE COAL INDUSTRY

(Editor's Note:—Following is a summary of an address by Herbert Hoover, Secretary of Commerce, before the Salesmen's Association of the American Chemical Industry at New York City on September 12, 1922.)

The favorable progress of legislation for the creation of a National Coal Commission fully empowered to get to the bottom of the troubles in this industry is the first step in one of the most vital problems we have. I have been earnestly recommending such a commission for the last three years, because I do not believe great solutions are to be found out of emotional denunciation, but out of sober scientific examination.

Present Condition Very Bad

When the public can be made the victim of infinite loss and suffering by such disagreements as we have witnessed; when the whole nation can once every two years or less be pushed to the edge of the precipice of want and commercial collapse; when our public utilities, hospitals, schools and kitchens are dependent upon short rations of non-union coal; when the Federal government is forced to interfere with business and transportation to secure even this movement to essential points; when we are brought to consideration of price fixing against extortion in peace time; when hundreds of thousands of workers not only in the industry but outside of it are thrown into skimping and starving; when the nation is made to suffer the shame of Herrin and rampant crime that has followed in train of strikes —then some examination of our industrial sanity is called for.

There is much in the industry that needs public ventilation, but more important than this, there are two distinct lines of problems for which constructive solutions are needed, that can only be furnished after more considered investigation. The first of these problems is the employer-employe relationship; the second is economic reorganization of the industry.

Fair Play Hard to Establish

The present relationship of employer and employe in the industry comprises a periodical national danger, because, with national organization and national disagreement, it means national stoppage. In the end, the issues of the struggle are consciously or unconsciously imposed by pinching the welfare of 99 per cent of the community, who are not parties to the quarrel. And through subsequent prices the public pays the bill. The public therefore has a right to a voice in this whole business.

Surely fair play can be obtained for employer and employe in our civilization without war on the public. But it is not sufficient to shirk the issue by saying that there must be fair play. We must discover the machinery by which fair play can be delivered to all sides. We must have continuity of production in this essential commodity under righteous conditions of employment if we are to maintain the welfare of the nation at all.

Interruptions to Production

I believe such a commission would find that collective bargaining, conciliation, and arbitration upon their present basis of organization have in sequence broken down in this industry, as witness the long stoppages in production which all these processes are supposed to end. In this connection, if we examine the inside workings of this recent strike, we will find situations new in industrial relations. Under freedom from the restraint of trade laws the workers' organizations have grown in strength, solidarity and devotion; they have shown able leadership, whereas the organization of employers for the purpose of collective bargaining has been to a large degree destroyed by the action of these very laws. Without entering into the history or rights or wrongs of this phase, the bare fact exists: That the recent agreement in the bituminous industry was determined by only 15 per cent of the employers, and this minority's decision controlled the whole.

From the public point of view, these things are only of importance as they contribute to interruption in production. The greater proof that the conception of collective bargaining in this industry has failed upon its present basis to secure any assurance of protection to the public is the famine in coal.

Federal Laws Have Failed

The Federal laws on conciliation have failed to obtain any results for peace. The

conception of arbitration is a settlement based on mutual agreement to abide by the decision of a third party, but this is now refused "on principle," for in this industry the workers consider that arbitration always results in compromise and that this is compromise with their bread and butter. Thus all of the old conceptions of mutual settlement in the industry have failed. We may well preserve the old methods of peace but of a certainty they must be better organized, and we need something more that will bring a positive insurance of peace to the public. Nor is the organization of employers on a national basis the answer, for in such case, while collective bargaining might proceed more smoothly, the public could well take alarm that the costs of any bargain can be passed on to the consumer. Therefore such bargaining must be controlled in the public interest, even if it served to prevent stoppage.

The Public Right

There are a great many rights that have grown up around these industrial relations. Workers have a right to organize to protect and improve wages and conditions of labor. They have a right to collective bargaining. They have a right to strike. They have a right to refuse to join such organizations. They have a right to work without intimidation and assault. Employers have a right to refuse to recognize such organizations. They have a right to lockout. They have a right to keep open shop. No one seriously denies any of these rights, but a lot of people are overlooking a superior right. That is the right of the public to a continuous supply of its vital necessities and services upon terms fair to the employer and employe. When these various rights infringe upon the public right, then the dominant right is public right.

I do not propose to anticipate the conclusions of the Commission as to methods. My desire is to emphasize the vital importance of its mission.

A Multitude of Evils

Nor can the problem be solved solely by treatment of employment relations. There is essentially the need for constructive thought that will devise remedies for a multitude of evils that give rise to great industrial wastes, and breed much of the employment difficulties. They bring great burdens upon the public, workers and operators.

Aside from employe relationships, most of the economic demoralization lies in the bituminous, as distinguished from the anthracite, industry, and my discussion hereafter refers to bituminous alone. This industry, indeed, functions very badly. Some state glibly that it will work itself out if left alone. But it must be borne in mind that it has not been left alone in the past and the present situation is in large degree due to legislative interference. The control of combinations among operators without such restraint among employes, the rules of artificial car distribution, the state legislation of various sorts, and other acts have a great responsibility for the present condition. I am not here questioning the necessity of these measures, but their influence in the situation must not be overlooked and they must be either supplemented or amended by wise provisions, if we are to have coal peace.

Bituminous Industry Over Developed

There are 8,000 bituminous mines with an annual capacity of 850,000,000 tons—300,000,000 capacity beyond our national needs. The over-capacity in the industry results not in the permanent closing of some mines but in the operation of all of them more or less intermittently. Thus the working personnel is held attached to each mine in daily hopes of employment. In the best year of their history the bituminous mines operated an average of only 249 days in the year, out of a possible 308, whereas in most years the average is about 210, as against about 295 days in England and over 300 days in Germany. If we subtract the mines which are operating regularly for certain metallurgical and railway supplies, we find that the situation is even worse, for the remainder of the bituminous mines are probably operating an average of less than 180 days, or over 120 days lost time out of the year.

There are 2,500 too many bituminous mines and 200,000 too many people in the business. This waste of labor, of capital, and of coal levies tremendous tribute on the entire country. Investment in the industry is extremely speculative. Distribution costs are excessive. The operators vibrate between bankruptcy and high profits. And the public in ordinary times is paying far more for its coal than would be necessary from a stabilized industry.

The perpetual labor difficulties are but one of the inevitable by-products of this poor organization. Labor is struggling on one side to set up remuneration based on such day's pay, and such piece-work rates, as will give a standard of living, from 60 per cent of time employed. Labor

is thus honeycombed with the worst of stimulants to unrest: insecurity of employment. At the same time, men who have the opportunity to work full time in regularly operating mines earn returns far above the average income of our most prosperous farmers and other workers. There can be no solution either to the operators or to the workers as long as this condition continues.

The largest contributor to over-expansion of the industry is now the almost regular biennial quarrel, with its undue prior demand for coal and its subsequent shortage with temporary high profits. This results in intermittent operation of many mines at a loss in the lean period between strikes or threats of strikes. The war demand and profits have also contributed this over-expansion. Beyond this the non-union mines in the south, with a capacity of over 300,000,000 tons per annum, being able to secure a lower wage level than the union mines in the north, at times of sharp competition are enabled to undersell northern coal, and are gradually causing the industry to migrate from the north to the south, with consequent over-equipment in the north.

Annual Shortage of Railway Cars

Intermittent operation also arises in the chronic annual shortage of railway cars because a sufficient car supply for the short-peak period is economically impossible to the railways. A bad system of distribution of cars to mines by the railroads contributes also, because under the present methods the fly-by-night operator has a right to demand his quota of cars in times of good demand and paralyzes the ability of the systematic mines to comply with their contracts or to maintain regular operation. There is inadequate storage at points of consumption to take up slack from seasonal and daily intermittent production. The marketing machinery itself creates intermittency because of the incessant shifting of contracts from one mine to another. Furthermore the high unit wage basis encourages absenteeism and thus at times an irregular supply of labor; there is a perpetual rain of small and local strikes, all directly and indirectly contributing to intermittent operation—for all of which the public pays. What we want is greater continuity of production as a basis for smoother relations and lower costs.

The Storage Problem

Aside from relief from national stoppage in production from strikes and lockouts, there are proposals of constructive and practical remedies which should be investigated and which do not lead to socialism and destruction of the American freedom and initiative. For instance, an extra annual storage of 20 per cent of railway consumption would equalize the seasonal fluctuation. Larger storage is possible by the railways at those times when public demand for coal is slack instead of competition by the railways themselves with the public for coal, and thus for the use of cars, at the annual period of car shortage. A system of car distribution that would not itself break into regular operation would help. Larger storage by public utilities would assist and would give greater security to the public.

A contributing remedy that will need the most earnest consideration is the possibility of permitting the co-operative system of marketing developed by the farmers to be applied by such mines as wish to adopt it, under circumstances that would assure competitive conditions. Such an arrangement would decrease distribution costs, would give more regular flow to orders, would get better car distribution, would decrease transportation, would enable the laying down of coal in storage at points of consumption, and would consequently give more regular operation with reduced working costs. More accurate statistics of capacity, production, consumption stocks, and prices would greatly promote stability and would be in the true interest of the operators who are now blamed for much that is not their fault.

It has also been proposed, although I have doubt as to practicability, that there should be a penalty in higher wages for short-time employment. Proposals are also made for a basic wage with a participation in the realized price of coal.

Of dominant importance, however, is the fact that the whole employe and employer relationship requires reform if we are to secure a stable industry. Much friction would of course disappear if there were less intermittence. The instability of these employment relations themselves form a vicious circle of quarrels. Collective bargaining has a fundamental value in the industry in the maintenance of standards of wages and conditions of labor, for otherwise the workers, because of competitive drive for low costs, would never have arisen from the impossible conditions of years ago; but the breakdown of true collective bargaining in the biennial conflict, the constant local violation of agreements, and the multitude of

small strikes are themselves proofs that it needs better organization, and public participation with guarantees.

Some Want to Maintain Present Conditions

I recognize that stabilization of the industry, or anything that lends stability to the industry, is opposed by a small minority of speculative operators who use the periodically disturbed production to reap a recurrent harvest. It would be opposed on the other side by some of the more narrow-minded labor leaders who contend that their object in all industry is to reduce the number of hours of actual labor to some minor fraction of the whole year, or whose ambition is to drive the nation to socialism in desperation for coal, or who deny the public right to any voice. However, I believe that the constructive men on both sides are in full agreement that we must have a broader and better solution than results from the truces of the past few years.

These periodic wars in the industry are, therefore, in part symptoms of a disease. But before we treat this disease we must have a more accurate diagnosis. We must have adequate, accurate information from which to weigh the different causes. We must be able to apply to all the test of fact. From such an understanding we should be able to return this industry to sanity. The proposed commission has the greatest opportunity for constructive work since the war.

The public demands results; it is sick and weary of periodic warfare and futile attempts at solution.

POLLUTION OF WATER SUPPLY SOURCES

By Edward E. Wall, Water Commissioner, City of St. Louis, 312 City Hall, St. Louis, Mo.

Twenty-five years ago or so, in discussing water supplies for cities and towns, the weight of expert opinion seemed to incline towards the prevention of pollution of streams from which communities drew their water, rather than towards sanctioning the application of purification processes to water taken from contaminated sources. At times the debate over this question grew acrimonious and many arguments pro and con were adduced, which afterwards were proven to be entirely unfounded.

One favorite stand-by of the opponents of purification by chemical treatment was the old belief in the self-purification of streams—that a certain distance below the point where sewage or other waste was dumped into the stream, the water would be found to be as free from contamination as it was above that point. As eminent an engineer as Captain Eads said of the Mississippi river at St. Louis: "I think before the water runs half a mile it has a tendency to purify itself; the main drainage of the city affects the quality to a certain extent but I apprehend that only a few miles below the city we find the water as pure as we do above it."

In those days the danger of using untreated water from contaminated sources was not realized as it is today, nor were there any standard methods of determining whether or not a water was safe for human consumption. As late as 1900 the contention of St. Louis that Chicago, by turning its sewage into the Mississippi river, was poisoning the water supply of the southern city, was vigorously contested, and experts employed by Chicago sought to prove that all noxious effects had disappeared long before the polluted water reached the mouth of the Illinois river. Many experiments were made to determine whether or not disease germs survived a journey of one, two or three hundred miles in the sluggish current flowing towards the Mississippi, but the most conclusive of all tests showed that the water supply of St. Louis was very materially affected, for both the typhoid and the general death rates steadily rose after the opening of the Chicago drainage canal.

It was not until St. Louis installed purification of its water supply in 1904, that the death rates began to decline, and soon the question of the contamination of the Mississippi river with Chicago sewage became a dead issue.

Within the last 20 years the study and practice of the purification of water supplies at one time advanced to the stage where the degree of pollution of the raw water became a matter of little concern, as it was generally believed that a safe and potable water could be supplied from grossly contaminated sources. The rapid development of the science of water purification proved of inestimable value to all cities and towns dependent on surface waters for their supplies, as it at once seemed to remove from further consideration the questions of restricting or prohibiting the pollution of water courses, of policing drainage areas, and left each community free to discharge its untreated

waste into the source of water supplies for neighboring communities. This absolution from responsibility for the effects of unmoral actions, this policy of leaving each individual or each aggregation of individuals to take care of their problems regardless of the causes of their difficulties, is bound to prove demoralizing and eventually to lead to far worse troubles than the initial ones. Thus it is now, that the pollution of many sources of water supply have reached or are nearing the point where purification processes are either becoming so expensive as to be an almost prohibitive drain on the funds of the community, or more often are proving inadequate to safeguard the public health.

This brings us face to face with the question as to how far should the cost in money and health be allowed to accumulate in the case of one city or town because of the defilement of a stream by residents of another place above, before restrictions should be enforced on the offending parties.

The community directly above the aggrieved town may plead prior pollution of the stream before the water comes to its doors, holding with entire truth that the degree of pollution which would be produced in a pure stream by their sewage would not be beyond the allowable limit, but because of the general noxious condition of the stream, other people above them should be held in some degree responsible for the objectionable situation and should be made to bear their equitable portion of the cost of remedying the evil.

Obviously the task of apportioning the responsibility and proportionate share of this cost among the numerous offenders would be no easy one. Another reason why such a procedure would prove impracticable is that the science of water purification has not yet advanced to the point where a grossly polluted water can be certainly and continuously converted into a harmless potable water. The only other practicable alternative is to prohibit the pollution of water supply sources beyond the point where it is easily possible to produce a safe water for domestic use and at a reasonable cost. Wherever the limit of pollution was reached in any case, no contaminating waste should be allowed to be discharged into that water without prior purification.

The United States Public Health Service has lately published some results of an investigation into the self-purification of the Illinois river, (Fire and Water Engineering, Vol. LXXII, page 357) which show clearly the steady decrease in bacterial content until the stream is again contaminated with the sewage of Peoria and Pekin. Because of the gross pollution of this river with Chicago sewage and because it has no large tributaries, it affords an excellent opportunity for observing the effects of natural purification in the case of a highly contaminated stream, but in itself offers no especial information applicable to impure streams in general.

This investigation along with others of the same kind serves to show the general fact that if left without reinforcement, the impurities in all streams diminish as the water flows away from the source of contamination, just as also impounding the polluted water of streams in reservoirs brings about self-purification through the changes which occur in the organic matter, and the causes, whatever they may be, which shorten the life of bacteria and reduce their multiplication.

But the information available is not sufficient to enable us to determine how many miles any given stream must flow in order that its water may purify itself sufficiently, either that it is safe to use in its natural condition, or that the pollution is reduced to a point where its purification by the ordinary methods is practicable.

Neither can we set a definite limit on the extent to which a water may be contaminated and still be safe as a source of water supply, which it is practicable to purify.

The American Water Works Association through its Council on Standardization is endeavoring to determine from the results of operating purification plants, the actual loads carried by these plants, and whether it is possible or practicable to increase these loads and to what extent.

The great variation in the character of purification plants, the diversity of the methods used and the degree of skill exercised in their operation present a problem which will require long and careful study before any decided conclusions can be reached.

For example, the methods of purifying water supplies range from plain sedimentation, with or without filtration, to coagulation, softening and sedimentation followed or not by filtration and disinfection, with various modifications of detail, such as the use of preliminary filters or the

omission of softening or disinfection or both, all of which is complicated by the time element, often a very important factor.

Some places rely upon simple sedimentation in storage basins, others hasten settlement by the use of coagulants, but do not filter, usually depending upon disinfection with hypochlorite or liquid chlorine to protect the health of the community. Then there are the slow sand filters and the rapid sand filters, to each of which may be added, as an adjunct, preliminary or roughing filters. At some plants softening is necessary, or at least is practiced, bringing another factor into the purification process, and introducing new problems.

No matter how well designed any plant may be, nor how well-fitted it is to care for the local conditions, the skill with which it is operated is a matter of prime importance. Many of the smaller plants are sadly hampered by lack of funds, and their managers, no matter how capable or conscientious they may be, are forced to allow important matters to go by default. Therefore data from various plants must be interpreted with due allowance for the manner in which each plant is conducted.

But regardless of the type of the plant, the methods used and the manner of operation, there is one conclusive test which may be applied alike to all, and that is the test of use. Wherever the people served are satisfied, and shown to be healthful by the absence of water-borne diseases, it may be taken for granted that the purification of water at that place is efficient and all that could be asked for in treating the quality of their raw water.

Potable water supplies are being produced from waters containing a maximum of 23,000 B. Coli per 100 c.c., 1,200,000 colonies bacteria per c.c., 500 p.p.m. color, turbidity of 6,000 p.p.m., with disagreeable odors and tastes arising from contamination from untreated wastes from gas plants, oil refineries, coke plants, pulp mills, oil wells, sewage and organic matter.

While the water furnished the consumers from these grossly contaminated sources may be safe for domestic use and satisfactory to the majority of the users because they have grown accustomed to it, and have never known anything better, it would probably be very unpalatable to the visitors from other places which have an unimpeachable water supply.

A general standard may be set for a safe water for domestic use, just as the U. S. Treasury Department has established a standard for waters used by common carriers, but any attempt to place a limit on color, hardness, taste, odor, etc., would be abortive, since these characteristics vary with localities where each community sets up its own standards.

Casual observation of the data on highly contaminated sources from which satisfactory potable water is produced might lead one to conclude that methods of water treatment would improve as the quality of the raw water deteriorated, so that year after year communities could continue to obtain safe water from the same source regardless of conditions.

While the science of water purification has made remarkable progress during the last 20 years, it is far from being a certainty that it can keep pace with the growing pollution of the smaller streams.

If it were possible to produce water fit for human consumption from the worst polluted sources, still the item of cost would have to be considered—at some stage of the game a point would be reached where the cost of treatment would mount up to such a figure that the prevention of pollution would be cheaper and more practicable than purification. It does not seem likely that conditions will ever be allowed to arrive at this stage, because of aesthetic reasons if for no others.

Still there are even now some places drawing their water supplies from sources where the limit of pollution, so far as existing facilities for purification are concerned, is almost at hand, so that it is only a question of a comparatively short time until some action must be taken to prohibit the unlimited discharge of untreated waste into sources of water supply.

SOME THOUGHTS ON STREET WIDENING IN BUSINESS DISTRICTS

By C. E. Grunsky of C. E. Grunsky Co., Engineers, 57 Post St., San Francisco, Calif.

When the lands were subdivided on which the big cities of this country are now located, and certain portions thereof were dedicated to public use as streets no one had in mind that presently the elevator would come into use and that the intense use of ground space as exemplified in skyscrapers was a possibility. The experience of the world fixed the width of a good serviceable street in a large city at 60 to 80 ft. and necessity for street widths of 120 ft. or more, except

as boulevards, was rarely recognized. It is natural, therefore, that the traffic capacity of the streets of our cities is now insufficient. This would be still more so, in business districts if the horse had not been crowded from the street by the automobile. It is safe to estimate, that the automobile makes at least twice the speed of the horse, and that it occupies only one-half the space on the street that would be occupied by horses and wagons or horsedrawn trucks of equal capacity. The traffic capacity of the city street may, therefore, be assumed to have been increased about fourfold by the advent and general use of the automobile.

But, it is also true that where the automobile is used to render the transportation service which should fall to the street car, or to the elevated and subway trains, the demand upon the street by the individual who goes from his residence to his business by automobile and who perchance parks his car on the street for the greater part of the day, is much greater than need be.

If the present demand for street surface in relation to building area could have been foreseen when our large cities were laid out, it is likely that some such plan as that adopted for Washington would have been followed. Streets of the first class would have been made 120 to 150 ft. wide, with the understanding that only so much of the street would be paved and made available for traffic as required from time to time, leaving the paving of its full surface and the shifting of sidewalks back to the building line for the future. Under such a program, the property owner would have long been left in as complete possession and use of a fine garden plot in front of his premises as though he *had* been the owner thereof in fee.

Now, we are confronted with an embarrassing situation calling for a remedy. The skyscraper has come to stay. The intense use of the downtown lot is demanded and our American people have not the courage to say nay. On the street the parking of cars is restricted or forbidden. Other parking space is hard to find or entails a burdensome expense. Sidewalks are being cut down in width wherever property owners will consent, but frequently this results in deficient sidewalk area. Two-story streets are talked about and subways, particularly such as will facilitate the crossing of busy streets by pedestrians, also movable sidewalks and the like to overcome special difficulties but nothing that can fully take the place of the wider street, which can not be secured in the downtown business section of the big city owing to the prohibitive cost of acquiring the necessary ground space.

There will be many cases, however, where it is not too late to take steps to overcome the evils which have resulted from the lack of foresight, and two ideas are here suggested that may be helpful in solving some of the problems which appear to many impossible of solution.

Acquiring Land in Advance of Its Use for Wide Streets

In addressing a small group of citizens at Stockton, Calif., a short time ago the writer threw out the suggestion that Eldorado street in that city should be widened by acquiring at once, while the city is still young, a strip of land along its west side at least 60 ft. wide; but with the understanding that wherever the ground is already in use, as where covered by a building, a lease will be given to the present owner for any desired term of years not exceeding 25, at a rental of say 5 per cent per annum on the price paid by the city for the land and 7.5 per cent on the price paid by the city for improvements on the land. Opportunity would thus be afforded for the gradual adjustment of business to new conditions and the value of improvements at the time of dispossessing the original owner would be minimized. In this particular case it is recognized that Stockton must soonor or later provide itself with a wide north and south street and none other appears better adapted to fill all requirements than Eldorado street. The actual widening of the street under such a program, might have to be deferred for the full period covered by the longest leases to present owners of the strip of land required for the widening. If the city does not adopt some such program it will still, no doubt, get along in some fashion; and, when 25 years have rolled by, the needed improvement will then quite likely be found impossible of accomplishment or will in any event be very costly.

This plan of acquiring property years before the actual carrying out of an improvement is one under which many of the difficulties in the way of widening streets could be overcome, particularly when the price paid for any land taken is made the basis of the rental that will be required from its former owner.

Acquiring Sidewalk Space Inside Property Line

The other thought is along similar

lines, but relates to the acquisition of rights at the street level only, without disturbance of the building line for upper stories. There are no doubt many cases where the widening of a street due to the character of the buildings which line both sides would be impracticable but where it would be possible to acquire a 20 ft. right of way for sidewalk purposes inside of the property line. Wherever this can be done, even though the taking of possession may sometimes be long deferred, the surface of the street available for vehicular traffic can be widened sooner or later. This arrangement would have the incidental advantage, too, of giving the pedestrian shelter from sun and rain. The architectural arcade effect, moreover, can be made pleasing. It is hardly necessary to discuss the benefits that would result from such a modification of the common present day plan of making provision for both pedestrians and vehicles outside of the building line and the only question to be considered is the feasibility of any specific project. Where the required space is in use by a business concern which would abandon it with reluctance, the purchase of the right of way might well be made subject to a long time lease with rental determined as a fixed percentage of the price paid for the easement so that, if not now, at least after a quarter of a century, which is a short time in the life of a city, possession thereof could be taken. There will be many cases where the suggested arrangement would be welcomed, where the advantage to the storekeeper of the improved sheltered display facilities would be recognized. There is hardly a large city in the country where some arcades can not be found and where some of the stores with large floor space do not themselves provide sidewalk arcades. In carrying out any such project the plan could here, too, be followed of fixing the rental of temporarily retained floor space at 5 per cent on the amount paid for the easement.

WHY NEW YORK CITY NEEDS STORE-DOOR DELIVERY

An address on store-door delivery, which has been earnestly advocated by The Merchants' Association, was delivered recently by Mr. W. H. Connell, Assistant Manager of The Merchants' Association's Traffic Bureau, before the Society of Terminal Engineers, and is here reprinted from the Sept. 18, 1922, issue of Greater New York, the Bulletin of the Merchants' Association of New York.

What Store-Door Delivery Is

The store-door delivery system has long been established abroad. It consists of the delivery from freight terminals to the premises of the consignee or in the reverse direction, at an established public rate of merchandise in transit. This delivery constitutes a part of the continuous movement of the freight to the consignee and in the reverse direction and is included in the original shipping directions of the consignor duly covered in the bill of lading of the originating carrier's agent. It introduces order and economy where disorder and waste are now prevalent.

In discussing the subject Mr. Connell said:

"The Industrial Bureau of The Merchants' Association of New York, which Association I have the honor and pleasure to represent, informs me that there were 22,981 manufacturing establishments in the Borough of Manhattan in 1919, employing 519,647 persons and producing products valued at that time at about three and one-half billion dollars.

Important to New York City.

"From the same source I learn that there are approximately 7,500 wholesalers in Greater New York, the vast majority of whom are located in Manhattan and whose inbound and outbound shipments move largely in freight service. I am also advised that there are about 48,000 retailers in the Borough of Manhattan engaged in distributing goods, the greater part of which require freight service at some period in their distribution.

"To handle the greater part of the freight required by these manufacturers and distributors, there are upon Manhattan Island at the present time only 65 railroad freight stations. Is it strange, therefore, that times of great business activity, congestion or lack of motion due to unsystematized trucking of inbound or outbound shipments occurs at our terminals?

"Distribution deals with the movement, storage and sale of products from one agency to another until they reach the consumer, and the merchant in most cases looks upon the railroad as the most important movement or transportation agency. From his point of view there are three links in the transportation chain, each of which is vitally related to and dependent upon the other; namely, delivery to the carrier, transportation by the

carrier, and delivery to the consumer or consignee. The first and particularly the last links are the ones with which store-door or direct delivery must deal.

Three Needs to Be Filled

"From the merchant's point of view, store-door or direct delivery in order to be really effective must supply three fundamental needs, namely:

1. Safe delivery,
2. Quick delivery,
3. Delivery at a reasonable cost.

"The results of the ineffective supply of the first requirement are partly manifested in the volume of concealed loss and damage claims which merchants must file against the railroads. The term 'concealed' used in classifying claims means that the loss or damage was not visible at the time the goods were delivered to the carrier for transportation or when they were delivered to the consignee's truckman for movement to the consignee's store or other receiving point.

"During this year the volume of concealed loss or damage claims paid by rail carriers on shipments to or from New York averaged $7,500 per month. That the railroads consider the truckman an important factor in the handling of freight shipments is indicated by the questions asked in the standard form for investigating claims of this class. Some of the questions asked of the shipper are:

On what date was the shipment delivered to the truckman?

Was the shipment delivered to the truckman before or after twelve o'clock noon?

Was the delivery made to the carrier by your own truck? If not, give name of trucking company.

Give name of driver in either case, if known.

Would Reduce Losses

"Similar questions are asked of consignees. When the answers indicate that the goods were in the possession of the truckman overnight or a sufficient length of time to afford an opportunity for pilfery, the claim is invariably declined. I believe that an effectively organized, managed and operated system of store-door or direct delivery would insure to our merchants a greater percentage of safe deliveries to and from the carriers' terminals than is being secured at the present time. I know of no disadvantages which the merchant would suffer under an effective system of store-door delivery in connection with this need.

"The second fundamental need of the merchant is to secure quick delivery to or from the carriers' terminals. Engineers, perhaps better than any other class of men, recognize the fact that a straight line is the shortest distance between two points. Also the further fact that, circumstances and conditions being equal, freight movement over a straight line will reach its destination in a shorter period of time than via a circuitous route. I believe that an effective system of store-door delivery would insure the movement of freight from rail terminals to consignees' receiving points in a much straighter line and with a consequently lesser delay than is now being experienced.

Delay at Rail Terminals.

"Under the law the carrier is obliged so to place goods in its warehouse that they are reasonably accessible to the consignee, open to his inspection, and permitting their safe and convenient removal by the consignee or his agent. The carrier is also required to afford the consignee a reasonable time within which to take delivery. The last figures available indicated that approximately 60 per cent of the inbound freight handled at our Manhattan pier stations was not delivered within less than 48 hours after its arrival here. While this does not seem to be a very serious delay, when the volume of traffic requiring handling at our pier stations is taken into consideration it will be found that it is a most fruitful cause of congestion at our piers. The necessity for embargoes against our pier stations during the war period, due to slow removal of freight from our terminals, is so fresh in the momory of most handlers of freight shipments that further comment thereon is unnecessary.

"Previous investigations into the desirability of establishing store-door delivery and consideration of the several plans which were offered as a means to bring it about, indicate that the circumstances and conditions under which our merchants engage in business at New York differ very greatly. It is obvious that the merchant occupying loft space in a manufacturing building would have a lesser amount of room within which to store inbound shipments than would a manufacturing concern operating warehouses in connection with its producing activities. The same is true in connection with wholesalers and retailers. Some concerns have larger facilities than others and consequently can conveniently remove from the carriers' terminals and store on

their own premises larger quantities of freight.

"While the advantages of quick transportation would be a very material benefit resulting to New York shippers and receivers of freight under an effectively operated store-door delivery system, it must also be admitted that in some instances and under the requirements of some of the plans which have been advocated, there is a decided disadvantage to merchants ordering goods in excess of their receiving capacity at New York. It is believed, however, that the advantages of quick delivery accruing to the majority of the users of freight service at New York are far greater than the disadvantages which might be experienced by some merchants following the practice above stated.

Cost Must Be Reasonable.

"The third great need of our merchants is to secure delivery at a reasonable cost and herein lies most of the objections which have been made to the store-door delivery plans so far formulated.

"What is a reasonable cost for delivery to one man may be quite unreasonable to another, depending upon the type of goods handled and other circumstances and conditions under which the delivery is made. To my mind one of the great drawbacks to the store-door delivery plans heretofore presented has been the apparent lack of option to the merchant of securing the performance of the delivery service in such a manner as is most advantageous to him. However, where the plans do not provide for such optional delivery when they were originally formulated they have by subsequent amendment made such provision.

Consolidation of Trucking Facilities

"Perhaps it is impossible to establish a really effective system of direct delivery without consolidating the existing trucking concerns and equipment into two or three big companies. It seems to me, however, that even though this is done there will always be some concerns whose business requirements, in their own opinions at least, necessitate their ownership and operation of trucking equipment. I think therefore that the plan which is ultimately adopted will provide for the optional delivery to the merchant under such conditions as will not interfere with the operation of the general system.

"At present there are probably 150 to 200 public and private trucking companies handling freight from Manhattan railroad stations and piers. Even during periods of business activity one can walk along West street on the North River, or South street on the East River and see many trucks going to or coming from the freight stations with one, two or three cases for delivery to the carrier or to the consignee. It is true that when such a truck arrives in line at the piers the driver, if he has only one or two cases to deliver, can and often does secure the consent of the truckman preceding him in the line to place the case or cases upon his truck, the preceding truckman undertaking to deliver the goods to the carrier and arrange for delivery of the bills of lading to the truckman originally undertaking to make the delivery. The operation of trucking equipment in this manner, is not an economical method to the merchant, and this situation is created through lack of organization and systematic operation of our trucking equipment. Of course there are many concerns doing business here whose output may not exceed one or two cases per day and the shipments of these concerns must be handled. During August of this year the American Railway Express Co. made 2,626,000 calls to pick up outbound shipments from Manhattan, The Bronx, Jersey City and Brooklyn. During this period that carrier made 857,000 calls delivering inbound shipments, or a total of 3,483,000 calls. Of this total 85 per cent of the pick-up and delivery calls was made on Manhattan Island. Seven hundred and eighty-six vehicles were used to perform the service, 412 being engaged in pick-up service for outbound shipments and 376 for deliveries.

Average Number of Calls

"The average calls per vehicle in pick-up service during August were 6,400, or 237 calls per vehicle per day. The average calls per vehicle in delivering inbound shipments were 2,280, or 84.4 calls per vehicle per day.

"While no figures are available showing the number of calls per day of freight vehicles at railroad terminals, it is reasonable to assume that no trucking concern in New York City is making 84 calls per vehicle per day or even 71 calls per vehicle per day on either inbound or outbound shipments.

"Perhaps under the most effective system of store-door delivery which might be devised this record could not be attained, but every one with whom I have conversed agrees that under a properly operated system a higher standard can be reached than exists today.

Conclusion

"In January, 1918, the Directors of The Merchants' Association of New York approved a plan proposed by the Transportation Committee of The Association for relieving the congestion in the Port of New York.

"In March of that year, Hon. James S. Harlan of the Interstate Commerce Commission made a report to the Director General of Railroads at the beginning of which he stated he was confident that store-door delivery will 'afford substantial and prompt relief if put into effect.'

"In December, 1920, the New York Port and Harbor Development Commission recommended to the Governors of New York and New Jersey inauguration of voluntary store-door delivery by an organized motor truck medium.

"The desirability of establishing store-door or direct delivery at New York seems to be conceded by all representative organizations. One prominent member of this Society of Terminal Engineers stated in March of this year that store-door delivery and collection in one form or another, under the operation of natural law which requires the relief of congestion, will soon be brought about. That his prediction was sound is proved by a modified form of store-door delivery which is now effective. May we not reasonably expect that a more general form will soon be established and safer delivery, quicker delivery and delivery at more reasonable cost will soon be secured to the merchants of New York?"

WHY IT PAYS TO BEAUTIFY WATER WORKS GROUNDS

By R. E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

It is almost impossible to over-dress or over-do the beautifying of water works grounds. The first impression of a water plant, like the first impression of an individual, is gained from appearances and may be favorable or unfavorable. The water plant does not exist that can afford to ignore public opinion. Without favorable opinion, it is almost impossible to make 100 per cent collections, difficult to enforce regulations, and useless to attempt the raising of funds for extensions or rehabilitation.

Out of approximately 6,000 water plants in the United States, it is a safe estimate that half of them have no ornamentation or artistic treatment of the grounds and their appearance is such that public opinion is unfavorable concerning the works. About 80 per cent of all water expenditures are for wells, mains, conduits, services, meters, and other underground structures; consequently, the buildings and grounds constitute a relatively small expenditure in comparison with their importance from the standpoint of the visitor. The entire water plant is judged by the appearance of that part visible to the layman.

If the grounds are clean, well kept, artistic, and pleasing to the eye, the whole plant instantly receives favorable approval. The money spent in beautification of the grounds is a wise expenditure and a good advertisement for the entire city, for cities are judged by their water supplies. The health record of a city is an indication of the kind of water supply it has.

The safety and purity of a water supply is often judged by the external appearance of reservoirs and surroundings. A feeling of security of health is assured when buildings and grounds are immaculate in appearance. Even the smallest plant can afford a few flower beds, shrubbery, and perhaps a little pool or fountain. I sometimes think women would make better water officials than men, their artistic temperament is more highly developed and they would at least apply their good house-keeping principles to the grounds and station.

Some cities have either located their stations in city parks, or Park Departments have taken over the grounds as a part of the park system. South Bend, Indiana, has its principal station in Riverside Park and the architecture of the buildings and character of improvements were designed in keeping with the surroundings. The St. Louis water works surroundings are very elaborate, consisting of fountains, pools, shaded paths, and beautiful drives, making it one of the show places of the larger American cities. Rochester, N. Y., has in its water reservoir a fountain that adds to that city's fame and reputation and is long remembered by visitors. Our ancient aqueducts, with their graceful vine-covered arches, were structures of beauty, but with the advent of pumping machinery and pipe lines in their places, we are not seeing as many pleasing water structures as formerly existed.

No one ever questions the wisdom of this expenditure for beautification. It pays for the small town as well as the

large city. It is good advertising and good business for the superintendent, the mayor, the Water Board, and the city and it does the consulting engineer no harm to give to his job an attractive appearance.

The foregoing matter is from a paper by Mr. McDonnell before the annual meeting of the Southwest Water Works Association at Hot Springs, Arkansas, on Sept. 26, 1922.

REDUCING THE INDUSTRIAL POLLUTION OF INDIANA STREAMS

Determined that pollution of public waters in Indiana shall be held down to a minimum in order that public health be protected and safeguarded, the state conservation department has started a campaign against firms and corporations which it is charged continue to discharge refuse matter into streams and rivers with the direct result a tremendous amount of aquatic life has been killed and the health of the citizenship menaced.

The courts are appealed to as a last resort in the campaign for improved conditions, says Richard Lieber, director of conservation in Indiana, and it is gratifying to note that in the hundreds of pollution cases coming to the department's attention each year, only a few necessitate settlement in justice tribunals. Others have been disposed of satisfactorily by the department and the firm or individual co-operating to a common end and to mutual benefit.

Mr. Lieber announces that the Citizens Gas Company of Indianapolis, charged with polluting Fall Creek because of a contaminating discharge of tar emulsion from the company's Langsdale avenue plant, has been convicted in the Indianapolis City Court. The company appealed the case. Other suits filed to date are against the Princeton Canning Company for pollution of Big Lick Creek at Brownstown; Snider Preserve Company, of North Vernon for polluting the Muscatatuck river; the Swine Breeders' Pure Serum Company of Thorntown for pollution of Sugar Creek; the Paper Board Company and the Ft. Wayne Corrugated Paper Company for pollution of the Mississinewa river at Marion.

Affidavits are prepared and will be filed as soon as the various circuit courts convene in fall session, against firms at Ladoga, Franklin, Zionsville and Pierceton, and it appears at this time that the cleanup campaign of the conservation department will extend to the point of court action against firms at Elwood, Acton, Shelbyville and Sharpsville.

The conservation department through its counsel, will prosecute all pollution cases under the statute making it a criminal offense to kill or injure fish by polluting a public stream. The penalty upon conviction is a fine of not less than $50 and not to exceed $1,000 each day, with court costs. Each day the offense continues constitutes a separate case, the law reads.

Civic interests all over Indiana are awakened over the matter of stream pollution, conservation officials say, and have at last recognized that the time is here when a halt be called on this public nuisance so menacing to the health of the commonwealth. In most cases, it is pointed out, that firms and corporations responsible for stream pollution, have willingly aided and co-operated with the conservation department to remove the menace. For instance last year the Holland-St. Louis Sugar Refining Company of Decatur, at the instigation of the department, improved its plant by installing modern machinery at a cost of $250,000. The result was the company recovered an extra ten tons of sugar each operating day which formerly was discharged in St. Mary's river as pure waste, and which polluted that stream for a distance of 25 miles. In addition the beet rootlets which constituted the source of contamination when they decayed, are now reclaimed at the rate of 30 wagon-loads a day and converted into stock food that brings financial returns to the company. St. Mary's river is also free of pollution from this source, it is pointed out.

In the opinion of conservation officials the public is determined that pollution of public waters cease, and already hundreds of letters to the department lead officials to believe that more drastic legislation will be sought at the next General Assembly.

RECENT DEVELOPMENTS IN SEWAGE TREATMENT

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(Editor's Note: The following summary of the more important recent developments in sewage treatment was made

by Mr. Fuller in his address before the annual convention of the American Society for Municipal Improvements held at Cleveland, Ohio, Oct. 2-5, 1922. The discussion is so interesting, and so authoritative, that we feel impelled to publish it all in this issue.

The purpose of this paper is to outline briefly some of the recent developments in this important field of municipal improvements, partly to indicate the trend of progress within the range of the writer's observations and partly to facilitate discussion on the tendencies now revealed as to the selection of types of plants for projected installations. A review of observations and experiences in a field as great as this can at best hit only a few of the high places and no attempt will be made to deal with technical details.

Skimming Tanks

At Toledo a pumping station is about completed which will deliver sewage from the intercepting sewer system into a "skimming tank," prior to dispersion of the partly clarified sewage through submerged multiple outlets, 10 in number, near the channel of the Maumee river and about 550 ft. from shore.

This skimming tank receives the sewage after it has passed through cage screens with a double set of bars having about 0.3-in. openings in the direction of flow; and in it the sewage will rise to a sufficient elevation to provide head for its discharge through the outfall pipes. The sewage in the tank has a circulatory movement due to the arrangement of the inlet and outlet. This causes an eddying effect so that the floating materials will rise to the surface, allowing grease to become attached to match stems, corks and other solid matters which will be removed from time to time by skimming the surface.

This device is closely similar to the skimming tank at Washington, D. C., which is described in the author's book on Sewage Disposal, page 405, and which has attracted much favorable comment because of the elimination of floating matters of sewage origin from the vicinity of the submerged outlets in the Potomac river.

The skimming tank at Toledo is arranged so that its performance may be supplemented at some future date by fine screens.

Fine Screening

Usefulness.—The usefulness of fine screening is indicated by its recommendation or adoption at a number of important projects for ocean outfalls and sewers discharging into tidal estuaries. Its adoption has been recommended at Los Angeles, Cal., and its use along the water front of New York City still continues, as shown by recent lettings for fine screens for sewers discharging into New York Harbor.

Probably the largest fine screenings projects now under consideration relate to use in connection with the activated sludge process at Milwaukee, Indianapolis and Chicago, where it is believed that the removal of the coarser sewage matters will improve practical operating conditions and effect economies amounting to more than the cost of fine screening.

Fine screens are also very helpful in many cases in removing sewage solids, to prevent clogging of nozzles of trickling filters, either in connection with or independent of preliminary sedimentation.

Types.—Recent developments in mechanically operated screens show that manufacturers are giving much attention to this type of device. The Riensch-Wurl screen, such as adopted for Bridgeport and described by Mr. McElroy in the 1920 Proceedings of the Society has found competition from cheaper types, such as the Dorr screen installed at New Britain, Conn., and Bethlehem, Pa., the Link-Belt Co. screen at Pleasantville, N. J., and the Rex screen as developed at Milwaukee by the Chain Belt Co. At Indianapolis, Mr. Hurd has designed a drum screen which is being built by the Chain Belt Co. at Milwaukee. To what extent cheaper types of screens will pass through experiences calling for heavier construction to make them durable, as was the case with the Riensch-Wurl screen following its extensive use in Europe, remains to be seen and need not be discussed here.

Disposal of Screenings.—Probably the simplest way of disposing of screenings is to turn them over to the local garbage and refuse department. This is done at the Dyckman Street plant in New York City and the screenings are barged to sea. Screenings may also be sent to a dump and covered promptly and adequately with earth so that they will not produce a nuisance. At Rochester it is understood that the covering is made with material removed from the grit chamber and that the quantity of this material is not always sufficient. At New Britain the screenings are lifted from the chamber, in which a Dorr screen is placed, by a bucket elevator with perforated buckets so as to

remove free water. The screenings are taken to a dump at an isolated site. Such dumps, if not covered with earth, may or may not give trouble from odors or flies. At Washington, Pa., the screenings are removed from the dump only once or twice a year just prior to spring and fall plowing, and not always completely on these occasions. The screenings from the plant are removed by a wheelbarrow on a runway arranged so as to permit, when necessary, of an adequate application of chloride of lime.

Fine screenings accumulate at the rate of 12 to 15 cu. ft. per 1,000,000 gals. of domestic sewage and in many cases are applied directly to land. This is done at Plainfield, N. J., day by day, where the screenings discharge directly into a manure-spreader from which they are applied to land and plowed in at frequent intervals during the warm season of the year.

Burning of screenings was practiced for some time in an oil-fed incinerator at Long Beach, Cal., but this whole plant, while seemingly working well at first, has been greatly overtaxed so that helpful data are not now available.

At Indianapolis Mr. Hurd proposes to mix the screenings with the settled sludge from the sedimentation tank of the activated sludge process and dewater the mixture.

Imhoff or Two-Story Tanks

Generally speaking the flowing-through compartments are made somewhat smaller than was the practice some 10 years ago, whereas all sludge storage and handling arrangements are made substantially larger than formerly. Even under these conditions two-story tanks while found to be efficient clarifying arrangements are not free from complications as to incomplete sludge digestion, foaming at gas vents, accumulations of floating sludge, and the release intermittently of large quantities of gas, so that on some occasions odors are transmitted for considerable distances.

Upper Compartment.—The flowing-through compartment is now ordinarily built of a length of about 70 to 90 ft. Longer tanks are scarcely worth while because there is very little increase in clarification after the sewage has traveled from 30 to 50 ft. from the inlet. Thus with the shorter tanks, upon reversing the flow, the sludge is quite well distributed in the digestion chambers. Linear velocities should not exceed about 1.5 to 2 ft. per minute under ordinary conditions. Velocities in excess of 2.5 ft. per minute show a falling off in the removal of suspended matters. Detention periods earlier figured at two to three hours may well be cut in two for average flows, without affecting the degree of removal of suspended solids.

Vents.—These should occupy about 20 per cent of the total area of the tanks. Smaller vents are liable to give trouble through insufficient provision for handling floating matters and through irregular release of gases. On the other hand, much larger vents and extensions of the vents for several feet above the flow line in the tanks do not entirely stop foaming over into the flowing-through compartment or irregular release of gases.

Lower Compartment.—The percentage of water in the deposited sludge is apt to be very much higher than was formerly anticipated. It is not safe to figure on less than 90 per cent and in the case of tanks at Plainfield, N. J., and York, Pa., dealing with the flow of separate sewers, the water content has frequently been found to range from 93 to 96 and average about 94 per cent. This means that the sludge chambers should be much larger than originally figured when based on about 85 per cent water content.

In the northern states where sludge is not removed during the severe winter season the sludge storage on a per capita basis should range from 1.7 to 2 cu. ft. per capita. Even this does not provide from more than about six months' storage of the sludge on an average, as against a nine months' storage period which may be desirable for some localities. On the other hand, in southern climates where sludge may be removed frequently during the winter months the sludge storage may be made somewhat smaller.

In recent instructions, issued by the Minnesota State Board of Health, it is specified that the sludge capacity shall be at least 2 cu. ft. per capita, with a plant handling sanitary sewage; and 50 per cent more than this for tanks handling the flow from combined sewers. It is furthermore stated that this capicity should be figured from a plane 2 ft. below the slots and above a surface at an angle 30 degs. from the horizontal and beginning at a point 8 ins. below and directly under the lower edge of the sludge removal pipe.

A recent design for Fort Worth, Texas, provides for 1.21 cu. ft. per capita of sludge-storage space which is considered sufficient with sanitary sewers for the

climatic conditions there prevailing.

Tank Covers.—For control of odors buildings over Imhoff tanks have often been considered, although, with perhaps the exception of a plant at Austin, Texas, none have been built.

Reversed Flow.—At Huntington, L. I., where the effluent from Imhoff tanks discharges into the harbor, the plant operator has changed the connections at the ends of the tanks so that the sewage may enter the gas vents at a velocity sufficient to move along for a considerable distance from the inlet end. Then the sewage moving downward is mixed with the contents of the digestion chamber, with its contents of black sticky sulphide of iron, and rises up through the slots and thence out through the outlet end of the flowing-through compartment. Within certain limits it is believed that this arrangement brings about additional clarification through the coagulating effect of the gelatinous iron sulphide.

Sludge Beds.—The original provision of 0.33 sq. ft. per capita for area of sludge beds has been found to be much too small in northern climates, where little or no use may be made of the beds for 3 or 4 months during the colder season of the year and where frequent rainfall interferes with drying during the warmer months. In the northeastern states the writer has found it advisable to provide 0.75 sq. ft. per capita for plants dealing with sanitary sewage. In the case of combined sewers the sludge beds ought to be at least 1 sq. ft. per capita. The latter limit is called for by the Missouri State Board of Health.

Separate Sludge Digestion Tanks

Experience in this country with digestion of sewage sludge removed from sedimentation tanks to independent tanks devoted exclusively to the digestion of the sludge is somewhat limited.

Extensive use, however, has been made of separate sludge digestion tanks at Baltimore in connection with hydrolytic or single-story sedimentation tanks in which the sludge is more or less digested prior to removal. In 1914 these separate sludge digestion tanks consisted of 3 square tanks and 16 circular tanks with a combined volume of 939,000 cu. ft. At that date the average sewage flow was approximately 23,000,000 gals. daily of an average strength approximating 100 gals. per capita. For a time these tanks worked well as regards sludge digestion but gradually became overtaxed during the war period. By 1920 the average daily flow was more than 52,000,000 gals. and the construction of more digestion tanks was undertaken. When adequate tankage is available, it is stated by the Baltimore operators that the sludge digests well in separate tanks, but if the tankage is relatively small some of the sludge may reach the outlet in an undigested condition.

Single-Story Tanks Used in Rotation

About a dozen years ago an effort was made with the old single-story septic tanks at Plainfield, N. J., to operate the tanks in rotation. The sewage was allowed to flow through one tank until the effluent contained objectionable quantities of suspended matter. Then this tank was put out of service and a second tank was placed in service until it also showed gas-lifted solids in the effluent. In this way three tanks were devoted to sludge digestion while one was receiving the sewage flow for sedimentation. The plant became overtaxed and did not serve the purpose satisfactorily although there were substantial advantages in this style of operation as compared with the use of the tanks in parallel. The plants at Morristown, N. J., and at Washington, Pa., since their early days, have been operated in this manner and until the plants were overtaxed satisfactory results were obtained. Within certain limits these arrangements allow a separate digestion of sludge and of scum in the tanks where there is sufficient sewage to dilute the toxic products of decomposition, and if a tank is allowed to digest, as is the case in the lower compartment of two-story tanks, it is feasible to remove the sludge in a well digested condition.

Another advantage of this process is that it provides for tanks of a depth of not over 10 ft.; preferably covered with a tight concrete cover, an important factor in preventing a dissemination of odors.

The removal of the digested sludge is not so convenient as with two-story tanks since it requires special labor and flushing from a hose, and also handling considerable septicized sewage found in the tank above the digested sludge.

This type of tanks should be built in 5 or more compartments with a total capacity of 18 to 24 hours of average daily sewage flow. They are much cheaper to install than tanks of the two-story type, especially where quicksand or rock is encountered.

This is the type of tank recommended shortly before the armistice for adop-

tion for army camps. Limited funds among other reasons resulted in its recommendation recently for a large state hospital at Morris Plains, N. J., and also at El Paso, Texas, it is understood, because of quicksand at the most suitable available site.

Plain Sedimentation With Continuous Sludge Removal

At Syracuse, N. Y., extensive tests have been made with sedimentation tanks arranged with scrapers working along the bottom of the tanks from the outlet toward the inlet end. It was found that the velocities should not exceed about 1.75 ft. per minute and that the detention period need not be more than about three-quarters of an hour. Thus at Syracuse about 60 per cent of the suspended matter was removed, with comparatively little improvement resulting from a longer detention period or a lower velocity. Continuous removal of the sludge prevents the formation of gas and of gas-lifted floating sludge. Floating matters are retained by scum boards. Solids removed from the floor of the tank by the scrapers will be mixed with wastes from the Solvay Process Company.

At Indianapolis "concentrate thickener tanks" have been designed, 4 in number, 15 ft. wide at the top and about 120 ft. long. The floors of these tanks will be scraped by moving scrapers from the outlet toward the inlet end at a speed not to exceed 5 ft. per minute. These tanks will receive the solids rejected by the screens, and their effluent may be sent to the river or pumped to the influent of the aerating tanks of the activated sludge process. The sludge from the thickener tanks will be mixed with the settled sludge coming from the activated sludge process and the resulting mixture dewatered.

Contact Beds

Under ordinary conditions contact beds are not as economical as regards total cost as are trickling filters. However, for some institutional and small city plants, they have a distinct field of usefulness. For large institutions and residential towns they afford the advantage of not calling for as great isolation as trickling filters, in that they do not expose the sewage to view until after it has been rendered non-putrescible in beds to which clarified sewage is applied beneath the surface. Furthermore, the filling of the voids in the stone prevents trouble from flies.

In Ohio, where the tax laws make it important as will be explained beyond, to minimize operating expenses it has been found that in some instances the smaller head required for contact beds justifies the greater investment through the elimination of the need for pumping with its attendant operating costs. Contact beds have been adopted at Marion and other places in Ohio.

In securing a non-putrescible effluent it apparently makes very little difference whether single or double contact beds are used as the loading per cubic foot of material seems to be the controlling factor. Where the effluent is to be discharged into a fairly small stream above the intake of a water supply there is considerable merit in using contact beds followed by sand beds as is done in numerous cases in New Jersey. If the stone in the contact bed is of a relatively large size it is prudent to provide a settling basin between the contact bed and the sand bed.

Trickling Filters

There are dozens of trickling filters which have been in successful service from 10 to 25 years in this country and England. Taken as a whole they have been as successful as, if not more so, in producing practical accomplishments, in line with what was earlier expected of them, than any single group of treament devices in existence. Twenty to 25 years' use has not caused need for cleaning English filters and records of a similar nature are available in this country with plants that have been in service a dozen or more years.

Aside from the general commendation as to their performance, trickling filters are worthy of note here in relation to three factors that are frequently discussed by sanitary engineers. They relate to the question of odor, plant loadings and control of flies which may be objectionable in the neighborhood.

Odor Control.—Trickling filters will not produce objectionable odors, noticeable more than one to three hundred feet away, if they receive sewage which is not partially decomposed or septicized. "Nozzle odors" are to be found at some plants where decomposing sewage reaches them through septic tanks or, in some extreme cases, where the sewage is in a stale and putrefying condition before it reaches the preliminary tanks. Bothersome conditions arise from foaming tanks, of the two story type, particularly when the tank effluent contains decomposed matters in substantial quantities either from

overflowing gas vents or from the entrance of material from the lower into the upper compartment.

In connection with nozzle clogging it is to be pointed out that even where tanks are used, the use of screens to retain floating matter is sometimes highly desirable, as is evidenced at Baltimore and elsewhere. Furthermore, complete freedom from nozzle clogging is not possible, owing to the intermittent detachment of the accumulations of fine suspended particles which adhere to the inside of the influent distribution system to which the nozzles are attached.

Experience at Brockton, Mass, for some four or five years shows that nozzle clogging can be kept in reasonable control by the continuous use of fine screens. Similar results are recorded by Mr. Hammond at Brooklyn, N. Y., in his experience when operating for some months trickling filters receiving screened sewage.

Filter Loadings.—Behavior of trickling filters in practice shows that for the ordinary 6 ft. bed a two-million-gallon rate per acre is by no means excessive. This equals 3333 persons per acre foot with sewage of fairly normal strength, say 100 gals. per capita daily. Special tests made at Schenectady and experiences at some other plants where filters were overloaded indicate that a non-putrescible effluent may be obtained with rates in excess of these, say up to 4,000 persons per acre foot. This is particularly true if the beds are made somewhat deeper than usual so as to guard against passage of some of the influent too quickly from top to bottom, and further providing that the spacing of the nozzles and the head upon the nozzles is such as to secure a distribution of sewage over the surface of the bed as uniform as practicable, and more uniform than is found at quite a number of plants now in operation.

In northern climates there is some falling off in nitrification of the effluent during winter months, although this seldom cuts much figure as regards objectionable conditions in the body of the water into which the effluent after sedimentation is discharged. In southern climates on the other hand it is feasible to use filter loadings substantially greater than in the north and equal in some cases to fully 5,000 persons per acre foot.

Filter Loadings with Unsettled Influent.—The loadings above mentioned relate to sewage that is passed through sedimentation tanks. When the latter are omitted and the sewage passed through fine screens the removal of suspended and organic matters is much less and it is necessary to consider carefully what the adjustment in loading should be.

First it should be recalled that nozzle clogging is not a point at issue in this connection. Secondly, it should be recalled that screened sewage from the ordinary American city contains no more suspended matter than does the settled sewage of many European cities, or of some American cities in the southwest where 100 per cent meterage and other factors minimizing water consumption reduce the flow of sewage to from 60 to 75 gals. per capita daily.

There are two aspects to this filter-loading problem in reference to adjustment between requirements for settled as contrasted with a fine screened influent. One factor is the suspended matter and the other is the organic matter. Tanks usually remove from 50 to 60 per cent more suspended matter than do fine screens and perhaps as much as 30 per cent of the total organic matter.

A further element to be considered is the result of experience accumulated in England by the Royal Commission as a result of its investigations for more than a dozen years. Their investigations are summed up on page 65, Appendix IV, Fifth Report, 1910, with the conclusion, expressed in American terms, as follows:

> This experiment, therefore, supplements experiments I and II in showing that a trickling filter of coarse material 6 ft. deep can treat a septic effluent of more than average strength and containing about 200 parts per million of suspended matter at a rate of 150 U. S. gals. per cu. yd. per 24 hours, or an effluent of half that strength with 100 parts per million of suspended matter at the rate of 300 U. S. gals., giving in both cases practically the same purification of organic matter and producing a good well oxidized effluent (apart from suspended solids).

Taking the strength of sewage as 150 parts per million, it is seen that this would allow, according to the Royal Commission findings, a rate of 200 U. S. gals. per cu. yd., equal to 3,250 persons per acre foot with an ordinary sewage flow of 100 gals. per capita daily or equal to a loading of 26,000 persons per acre for an 8-ft. bed.

At Lima, Ohio, with combined sewers, a recent design for trickling filters, preceded by fine screens alone, provided 3.6 acres of trickling filters 8 ft. deep to treat an estimated average daily sewage flow of 6,000,000 gals. from a population of 60,000 people. This is equal to a loading

of about 200,000 gals. or 2,000 persons per acre foot.

The suspended matter in the screened influent at Lima is estimated at 175 parts per million, which at the Royal Commission rating would permit a loading of 275,000 gals. or 2,750 persons per acre foot.

Fly Control.—On the surface and in the upper layers of trickling filters there is sometimes, but not always, found a small fly which accumulates at intervals in enormous numbers and which may be windblown for some distances from the filters so as to prove an annoying feature if not controlled. Dr. Thomas J. Headlee, State Entomologist of New Jersey, investigated this question at the Plainfield plant with the results as stated in the Journal of Economic Entomology, February, 1919, page 35. He found these filter flies to be principally "Psoyhoda Alternata" which grow in the films surrounding the filter stone. His investigations showed that the larvae and pupae breathe atmospheric air and if deprived of it for 24 hours they are destroyed. Flooding the filters at intervals of 10 days eliminates the fly growth because it takes two weeks for the flies to reach the adult stage. It is not possible, however, to eliminate thus the development of eggs which apparently will resist the effects of submergence.

By making trickling filters in compartments which can be flooded in rotation for 24 hours once in 10 days it is possible to keep the fly situation under control and to do so without materially disturbing the biological efficiency of the filter bed.

In all recent designs the writer has provided for this feature of submergence although at many trickling filters flies have not proved bothersome.

Activated Sludge Process

It is scarcely necessary to go into much detail as to the nature of this process concerning which many helpful data have been set forth in the Proceedings of this Society through the generosity of Mr. Hatton of Milwaukee; Mr. McVea of Houston and Mr. Hammond of Brooklyn. It is particularly fitting to refer to the operating results from these and other places, not forgetting the city of Cleveland with its extensive tests conducted during 1916-17, and special reference should be made to the Houston data of which an excellent summary appears in Engineering News-Record of July 27, 1922.

Performances.—Operating experiences show that by no means should there be misgiving as to the ability of this process to turn out regularly a clear, non-putrescible affluent from which 90 to 98 per cent of the bacteria in the raw sewage have been eliminated. Whatever may be said as to the practicability of the process relates not to the quality of effluent but to economies of the sludge-handling proposition in particular, and in general to the constructing and operating cost of the process in comparison with tricking filters. Comparative data will naturally vary in different places.

Adoption.—It is worthy of note that within the past year a plant of this type has been put in service at Gastonia, N. C.; the Maywood plant at Chicago is practically complete after long delays in construction; Milwaukee is constructing its aeration and sedimentation tanks; the process has been recommended and designs are being prepared for a plant to serve about 800,000 people in the northern portion of the Chicago Sanitary District; and this process has also been recommended for adoption for portions of the sewage flow of Los Angeles. Smaller plants are also being designed and built at a number of places.

Sludge Handling

This problem furnishes a live topic for discussion with experiences varying from time to time depending upon the state of the art as developed through various devices. The problem obviously is not now in the same light as it was during the war on account of the subsequent drop in the fertilizer market and the inability at the present time to dispose of dry sludge under any ordinary conditions at a figure approaching the cost of dewatering.

Hence, if the advantages of this process as regards freedom from odor and ability to produce a satisfactory effluent are to be availed of, it must, for the present, be adopted in connection with methods which will minimize the cost of sludge handling until such time as the market value of the dry sludge will equal the cost of dewatering. Of course there are exceptions to this rule where some of the simpler methods of sludge removal are not applicable and where at least partial drying is necessary.

There are even cases where the local demand for fertilizer may make it worth while to take unusual steps for delivery of either wet or dry sludge to the farmers in the general locality.

Lagoons.—To one who has not visited the Houston plants it is remarkable that activated sludge can be delivered from

settling tanks into lagoons and there allowed to accumulate year after year without producing nuisance. And yet that is a fact as recorded by the city officials of Houston and by every engineer so far as the writer knows who has ever visited Houston.

For the North Side problem in Chicago a Board of Engineers consisting of Messrs. Eddy, Hatton and the writer recommended the adoption of the activated sludge process, with a delivery of the wet sludge through a pipe line to the waste lands between the Des Plaines River levee and the main drainage channel. The sludge is to be lagooned there until such time as the cost of drying operations will not exceed the proceeds to be derived from the sale of sludge as a fertilizer. This is a suitable local solution of a difficult problem for a certain period during which it is expected there will be substantial advancement in the art of sludge handling.

Sludge lagooning is of course not universally applicable and conditions such as exist at Chicago and at the South-Side plant in Houston are by no means to be generally found. At the North-Side plant in Houston difficulty in finding adequate suitable land for a term of years has already led the city to consider carefully various means of sludge dewatering.

Maclachlan Process.—Much promise now attaches to this process which is primarily a conditioning treatment of sludge with sulphur-dioxide fumes which destroys the gelatinous character of the sludge floc leaving a fibrous and somewhat stringy solid mass capable of settling readily. This gassing results in a coagulating effect plus a partial sterilization of the sludge which tends to eliminate odor and decomposition.

It is claimed that the Maclachlan process prepares the sludge so that it may be either dried on sludge beds at the rate of about 1.3 lbs. of dry solids per square foot of bed per 24 hours as at Gastonia, N. C., or it may be passed through a cylindrical inward flow drum screen covered with 60-mesh brass wire cloth revolving about two-thirds submerged in a vat through which the gas-treated sludge is fed continuously. The free water passes through the screen and the sludge builds up a filtering sheet which holds back the finer particles. As the screen emerges from the water this sludge is picked up on a traveling felt belt similar to the "wet machine" used in the paper industry. After being picked up on the belt it is passed through squeezing rollers where some of the water is pressed out and it is then discharged from the belt in a thin sheet with a water content of about 80 per cent. This process has been tested at Houston beginning about the first of July and is said to produce a sludge cake of the water content above mentioned at a cost of from $5 to $7 per ton of dry solids.

Sludge Drying.—The limits of this paper do not permit of a description of the Oliver filter or sludge presses of various types which have been under investigation and which will doubtless receive further attention at Milwaukee and at the Maywood plant in Chicago before final conclusions are drawn.

As regards the drying of the sludge cake to the 10 per cent moisture required by the fertilizer trade, it is sufficient here to say that there is no reason to believe that this problem cannot be kept under reasonable control. Experiences in dealing with other odor-producing substances, however, show that dryers of ample proportions must be used and that adequate arrangements must be availed of constantly for the elimination of odors as well as dust by means of combustion chambers, dust catchers, spray jets and the like.

Fortunately data are now being accumulated at a number of places so that there is reason to believe that there will be opportunity to place activated sludge on the market commercially as soon as the economic conditions warrant.

Final Tanks

In all oxidizing processes other than sand beds there is need of settling the effluent, whether it be obtained from trickling filters, the activated sludge process, or the "direct oxidation" process. There is now a well defined tendency shown in various places to remove the sludge from such settling tanks at fairly frequent intervals, if not continuously, by the aid of Dorr thickeners, which facilitate the delivery of the deposit on the floor of the tank to a sump.

Electrolytic or Direct Oxidation Process

The use of electricity as a purifying agent has appealed and continues to appeal fascinatingly to the lay mind. For more than 30 years arrangements in which use is made of electricity have come up for consideration. The writer first became acquainted with the so-called "Webster process" of this type in London in 1890. In test plants this process was shown to be to a considerable extent a coagulating arrangement whereby elec-

tricity was used to decompose iron or aluminum electrodes, thus forming hydrates of these metals. The effective work was chiefly done in a manner more or less resembling the coagulating effect in water treatment plants in which use is made of sulphates of iron or alumina.

Undoubtedly there is some electrolytic decomposition of water even where iron and aluminum plates are used and bubbles of oxygen and hydrogen are released. Some of the oxygen is released in an atomic or anodic state whereby it has a high power for oxidizing even inert organic matter. Excessive cost has kept this process from general adoption.

Harris Process.—The writer investigated electrolytic arrangements of this sort at Louisville at considerable length in 1897, but they did not offer reasonable prospects for practical success. The arrangements tested at Louisville were known as the "Harris magneto-electric process." Plants of this type were installed for sewage treatment at Santa Monica, Cal., Oklahoma City, and a few other places. But practical accomplishments have been small and all of the plants have been abandoned except the one at Santa Monica which was found a year ago to be still in service under conditions greatly overtaxing its limits of effective performance.

Recent Developments.—During the past 10 years or so much attention has been given to improved arrangements, made largely through the efforts of the Landreth Company of Philadelphia, by the introduction of revolving paddles between the electrodes to remove the gases which cause polarization. Use was made of lime, presumably at the outset to increase conductivity and to lessen the quantity of electricity used per unit area of electrode.

The "Landreth electrolytic process" was installed some 8 years ago at Elmhurst in the Borough of Queens, New York City. It was investigated at length by the city officials of New York, preparatory to deciding whether to adopt the process for other plants within the city limits, but no such plants have been installed.

At Decatur, Ill., extensive investigations were undertaken shortly thereafter, but the process was not adopted and after a delay of some 5 or 6 years trickling filters are now being installed there.

Clark Process.—The "Clark Process" of the electrolytic type was devised and patented by J. M. Clark some 6 or 8 years ago when it received some attention in New Jersey. The successor to this process is known as the "Selo method" which is somewhat similar to the "Landreth electrolytic process" except that in the "Selo method" there is separate treatment of the sludge to which salt is added and there are certain differences in plant details. By this method the sewage is dosed with milk of lime in an agitating tank, then settled in a circular tank having a Dorr thickener and passed through an electrolyzer. The sludge is mixed with a solution of salt and electrolyzed, disinfected and deodorized by the sodium hypochlorite which is formed by the use of electricity. It is claimed that the sludge is rendered drainable to 60 per cent moisture in 48 hours so that it may be used as a fertilizer.

A plant of the "Selo method" was installed several years ago by the Thermoid Rubber Co. at Trenton, N. J. It is understood that the electrolytic features of this plant added little or nothing to the quality of sewage effluent and it was found on a recent visit there that the electrolyzers had been removed.

Direct Oxidation Process.—The Landreth patents covering the so-called "Direct oxidation process" have been controlled by the Municipal Sewage Disposal Co. of Philadelphia, which has installed two plants, one at Phillipsburg, N. J., and another at Allentown, Pa. At Phillipsburg the plant has been in service for about 2 years and last spring an extensive set of tests was made by the State Department of Health but the results have not yet been made public. At Allentown a 3,000,000-gal. plant at a cost of about $180,000 was installed and has been in intermittent service for nearly a year. Sanitary sewers in Allentown have been built only to a limited extent and it is understood that at present there are only about 700 sewer connections which produce a volume of flow which permits the treatment plant to be operated only a few hours each day.

At Easton, Pa., a test plant was installed in 1919 for demonstrating the practicability of the improved devices of Mr. Landreth, in which use is made of both electricity and lime, followed by sedimentation. This test plant was studied by several engineers and chemists of Philadelphia with results as stated in a paper presented to the Franklin Institute in 1919. The Easton plant was also investigated by the Pennsylvania State Department of Health with results as summar-

ized in Engineering News-Record of September, 1919, page 569.

As the "Direct oxidation process" now stands, it may be fairly stated that it has received widespread attention and that the merits of the process have come into sharp controversy. This means that adequate data for giving the process a true rating are seemingly lacking, at least to the extent of being persuasive to the minds of many. Briefly, the opponents claim this process to be no more efficient than if lime alone is used; that the process is unreasonably expensive to operate, especially where the sewage contains a very high amount of hardness requiring a large dose of lime; that the effluent, while very well clarified due to coagulating effect of magnesium hydrate, is not purified of its organic matter to a degree sufficient to serve the local requirements at many places; and that the destruction of bacteria by the process is not due to the action of electricity but on the contrary to the excess of caustic lime in the effluent which ranges from 30 to 80 parts per million.

On the other hand, the proponents of the "Direct oxidation process" claim that it is cheaper to install than plants of the biological type; that it permits an attractive looking and inoffensive plant to be located within built-up portions of the city; and that it allows the sludge to be handled in an inoffensive condition and dried so as to produce a product that is marketable.

It is not the purpose of this paper to go into great technical detail but rather to outline some of the main comparative features of the so-called "Direct oxidation process" and of so-called "Biological processes" as they have come into competition at Lima, Ohio. Controversial aspects of the local sewage problem as it now stands at Lima have produced a deadlock for the present year, leading to a series of claims and counter claims which are of some interest and perhaps of value as a warning guide.

Sewage Treatment Situation at Lima, Ohio

Lima is a city of about 45,000 population with several large manufacturing plants and a growing population outside the present city limits. It is located on the Ottawa river, having a drainage area of about 100 square miles. The flow of this stream, which passes through the heart of the city, becomes almost nominal during summer and is lessened by storage reservoirs above the city into which water is pumped from the river during periods when there is a substantial flow. The result is that the stream bed is practically an open sewer from which offensive odors emanate for a distance of several hundred yards on either side.

Due to the complaints of riparian owners below, the State Department of Health under the terms of the Bense Act ordered the city to purify its sewage. Fuller & McClintock made a report in 1916 on relief sewers, intercepting sewers and treatment works, recommending the adoption of the activated sludge method. But little was done during the war period and beginning in 1919 construction work related largely to relief sewers to improve conditions in the built-up part of the city where the original combined sewers proved inadequate.

In 1921, Fuller & McClintock were engaged to design intercepting sewers and treatment works. After considering the problem in detail they recommended the adoption of fine screens followed by trickling filters and final settling tanks equipped with Dorr thickeners. This decision, differing from the preliminary report of 1916, was made partly because of inability, with the activated sludge process, to treat the sludge in a way to yield any proceeds from its sale, but chiefly because under the Ohio law it is highly desirable, if not essential, to keep the operating expenses of sewage treatment plants at a minimum.

Under the terms of the amended Bense Act the interest charges on bond issues required for the construction of sewage treatment works when ordered by the State Department of Health to correct a nuisance, are not required to be paid from the general fund raised by taxation, to which there is a maximum limit of 15 mills per dollar of assessed valuation.

Operating expenses for treatment works on the other hand must be paid out of funds raised by taxation and must be kept within the 10-mill rate unless there is a special election to authorize, by vote of the people, a special tax above this limit; but in any event a limit of 15 mills cannot be exceeded.

Plans and specifications for the fine screens and trickling filters were completed and approved by the State Department of Health, subject to the provision that preliminary sedimentation would be required if found necessary. A letting was authorized with bids to be received on April 1, 1922. About a week prior to this date, the Municipal Disposal Co. of Philadelphia persuaded the City Commis-

sion at Lima to postpone the date of the letting and to take steps towards receiving alternate bids for a plant of the Landreth "direct oxidation" type. Plans and specifications for the latter were prepared and submitted to the State Health Department for approval. Specific data on the cost, method and adequacy of performance of the "Direct oxidation process" have been requested of the city officials by the State Department, and Col. George A. Johnson has been retained by the city to obtain information in respect thereto.

Several months have elapsed during which the merits and demerits of the trickling filter method (Contract A) and of the "Direct oxidation process" (Contract A-II) have been debated pro and con by the various parties in interest. Briefly, the situation may be summed up as follows:

1. The installation cost of pumping station and treatment works by the trickling filter method, with its established record of adequacy and successful performance for a quarter of a century, was estimated in December, 1921, at $691,000 as compared with a sum said to be about $400,000 for the proprietary arrangement with a number of novel features not yet worked out on a practical scale in a sizable plant.

2. The annual operating cost of the trickling filter method, including all pumping, fine-screen operation and sludge disposal from final settling tank, is estimated to range from $13,000 to $15,000 in comparison with which is an estimated sum of $40,000 for the "Direct oxidation" process. In this latter process it will be necessary to use, according to tests at Lima, about 2,800 lbs. of lime per million gallons and about 150 kw.-hr. per million gallons for electrolyzers, in addition to the costs of pumping and screen operation, attendants for pumps, fine screens, electrolyzers, Dorr tanks, and sludge drying plant (3 tons dry basis per million gallons) of the vacuum filter type. These estimates in each case are for fine screens operating at the rate of 4,000,000 gals. daily for 12 months per year and secondary treatment for the 7 warmer months. As the quantity of sewage increases later the financial disadvantage of the "direct oxidation" process will increase.

3. As to quality of effluent, the trickling filter plant will produce an adequately clarified and non-putrescible effluent, suitable for discharge into the Ottawa River. As regards clarification, the "direct oxidation" process, when an adequate dose of lime is applied, will produce the same result. But as to the removal of dissolved organic matter the evidence indicates that the "direct oxidation" process is no more efficient than "excess lime treatment" alone and that dissolved organic matter is not removed with substantial completeness but is simply left undisturbed in a sterile effluent so long as sufficient caustic alkalinity remains.

4. The "excess lime treatment" for sewage is not a novelty but was employed at London more than 30 years ago and was abandoned on account of the secondary putrefying reactions which took place with the organic matter on the bottom and sides of the River Thames.

CUTTING CORN AT CORNERS TO MAKE HIGHWAY TRAFFIC SAFER

Farmers and land-owners of Indiana were appealed to recently by John D. Williams, director of the Indiana State Highway Commission, to cut corn at corners on state roads to help make highway traffic safer.

In cases where a farmer finds it impossible, owing to stress of other work, to do this at once, Mr. Williams says maintenance division crews of the Highway Department will cut the corn for them.

Highway officials estimate there are many hundred places on state roads where tall corn growing close to the right-of-way makes highway travel exceedingly hazardous because it obstructs the view from either approach. Some land-owners have shown consideration to the traveling public by voluntarily planting low-growing crops. Others, cognizant of the danger, and anxious to co-operate in a common cause, have cut the corn and lessened the peril. It is only those who have neglected to care for this important matter that the Highway Commission, through its district engineers and superintendents, will endeavor to have act at once.

In the opinion of state highway engineers safe traffic on sharp turns and curves necessitates at least a 200-ft. sight distance from each approach. If this distance is lengthened, it is better.

Many farmers have written to the commission in the last few months that next spring they will plant only low-growing crops, such as beans, cabbage, tomatoes, turnips, etc., in fence corners, and will co-operate in every possible way to lessen the danger and to facilitate highway traffic.

Construction News and Equipment

HOW THE MOTOR TRUCK HAS CHANGED TRANSPORTATION PROBLEMS

(Editor's Note—Under the title, "Our New Colossus of Roads," a very interesting article was published in The Industrial Digest for Sept. 16, 1922. The article shows how the development of the motor truck has changed transportation problems and how it may alter the industrial map of the future. It is such a valuable summary that we reproduce it here.)

If you want to get a vivid impression of the size and importance of the automotive industry, stand by the side of the Boston Post Road, which connects New York City with Boston and way cities, and watch the motor traffic. Silent passenger cars will speed past in a constant procession, so fast and so many that you will grow dizzy if you try to watch them closely. Heavy motor trucks will be interspersed among them, carried in the stream like logs in a river. Men, women and commodities—apples, brick, plaster, iron, wire, lumber, oil, poultry, silks, trunks and vegetables—will roll before you, drawn by humming gasoline engines to places where there is need for them.

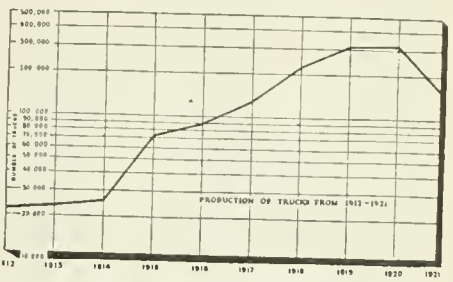
Behind this and similar scenes on roads all over the country, is the automotive industry of the United States, which has grown great by supplying the vehicles needed for road transportation. Nearly $1,500,000,000 is invested in the 407 factories which make motor cars and trucks. Their products are distributed and kept in condition by 78,739 dealers, repairmen and garage owners.

Right now, when the weaknesses of our railroad system are being made conspicuous by a prolonged strike and the prospect of congestion, it is timely to take stock of the situation in motor transportation, the only other practical means of carrying goods and persons overland about the country. What is the place of the motor vehicle in our transportation system? To what extent can motor transportation supplement locomotive haulage? What is the condition of the industry which supplies motor transportation?

* * *

The place of the automobile in the business of passenger transportation is quite obvious. It is thoroughly established as the best possible vehicle for the short trips which are a part of daily life. One significant observation is to be made on this subject: Automobiles are no longer called "pleasure cars" as often as they used to be. Passenger automobiles are used by professional men to carry them to their clients and patients; by housewives to do marketing; by business men for a hundred purposes. In the past few years they have ceased to be toys of the rich, and have become parts of the commonplace life of the country.

The development of the passenger automobile—especially the cheap car—is having an important effect on the real estate market. It is making possible the growth of suburbs further away from cities, and further away from railroads, than has formerly been considered possible. Roger W. Babson is greatly impressed with the



DIAGRAM, FROM AUTOMOTIVE INDUSTRIES, SHOWING PRODUCTION OF MOTOR TRUCKS IN THE UNITED STATES SINCE 1912.

importance of this. He has advised the subscribers to his statistical service to invest in suburban real estate now, simply because automobiles are plentiful. People, including workingmen, are getting tired of paying high city rents, he points out, and if they can invest in a cheap country house and a cheap car to carry them to work or to the railroad they will not stay in the congested districts.

From the viewpoint of industry in general, however, the passengar car is not nearly as important as the truck. Truck manufacturers now look forward to doing

a bigger business than they have ever done before. The use of trucks is growing in all fields.

A Sane View of Motor Truck Transport

There has been much loose talk about the possibility of the motor truck supplanting the railroad. Some enthusiastic persons give the impression that they think motor trucks could haul all the passengers and freight of the country. Of course that is nonsense. For long hauls the railroads are supreme, and probably will continue so, even if they fall into far worse condition than they are in at present. But for short hauls the motor truck is important. Even when the railroads are running well, it is often cheaper to ship by truck for a short distance.

The motor bus is a form of truck used for passenger traffic for which a great future is predicted. Busses are used for rapid transit in 108 cities, and the list is growing. In many cases they are competitors of electric street railways, which many persons (including the mayor of New York City) think they will supplant. But they are more important as feeders for such railways. Recognizing this, no less than 26 electric roads have established bus lines which they operate themselves, as feeders for the cars which they operate over their main routes.

Still other railroads use motor busses with flanged wheels for operation on tracks over short routes. The New Mexico Central R. R. runs a flanged-wheel motor bus line over 116 miles of track, and the New York, New Haven and Hartford operates a 104-mile route. Twenty-five other roads run shorter lines.

The railroad's point of view in this matter is expressed as follows by the Railway Review:

"Light local passenger service is undoubtedly the most expensive luxury, in proportion to the returns, that the railways can offer the public. Whether it be the daily branch line 'turn-around' or the main line 'short-dog' that must be maintained at the mandate of a state commission, it results usually in a very meagre return, while the expense of operation is often considerable.

"This is particularly true where a steam locomotive is used to haul a couple of passenger coaches. Under these circumstances it is seldom that the fuel consumption is less than 400 lbs. of coal per car mile, while a full passenger and engine crew must be employed. Locomotives retained in this class of service are invariably old and decrepit so that the cost of their maintenance usually runs high. Branch lines are seldom built for their passenger traffic possibilities, but once constructed, passenger service is demanded and must be constantly operated even after the original freight prospects may have become exhausted, so that these branch lines frequently transpire into white elephants on the hands of the owning railroads.

"Some years ago large gasoline driven cars entered the market and, subsequently, gasoline and electric cars were substituted for light passenger trains on many railways. Admirable and elegant in construction as these cars proved to be, their first cost in many instances approached that of a new locomotive and the intricacies of their mechanism often demanded a large share of official attention from the chief electrical engineer down. Faced with these discouraging circumstances in the operation of light passenger service, it has been particularly galling to railway management to observe the automobile truck and bus thriving on the very traffic that had caused the railways an actual loss.

"This situation has naturally been aggravated in the minds of railway managers by the fact that the automobile is being run over a road built and maintained by the taxpayers which, of course, includes the railways in large measure. It is as futile, however, to argue against the inroads which the automobile has made upon rail traffic or to suggest the prohibition of this automobile traffic as to remonstrate against the rapid spread of a forest fire.

"The most effective policy is to fight fire with fire. A very plausible remedy is suggested in the form of a rail motor bus. Following closely in detail the main features that are responsible for the successful performance of the automobile truck, it may be assumed a rail bus can be constructed which embodies the same elements of simplicity in construction, reliability in performance, flexibility in operation, light weight and low first cost. It is possible that if the rail motor bus is to be operated successfully as a substitute for the light passenger train in main line service, as well as on branch lines, that a maximum speed of more than 30 miles per hour should be attainable, but it is believed that, if designed to meet various local conditions, the field for a light gasoline rail car patterned after the automobile affords many interesting possibilities in the direction of economy and better service."

Enlightened railroad men see the importance of motor truck transportation, and welcome it instead of fearing it. Elisha Lee, vice-president of the Pennsylvania system, says:

"To the extent to which the motor cars are likely to take over the short haul freight traffic, the railroads will probably be immediately benefited financially, because short-haul business is becoming unremunerative on account of the high proportion of terminal costs which it must sustain. Altogether, I am not afraid of motor cars and aeroplanes making railroads obsolete."

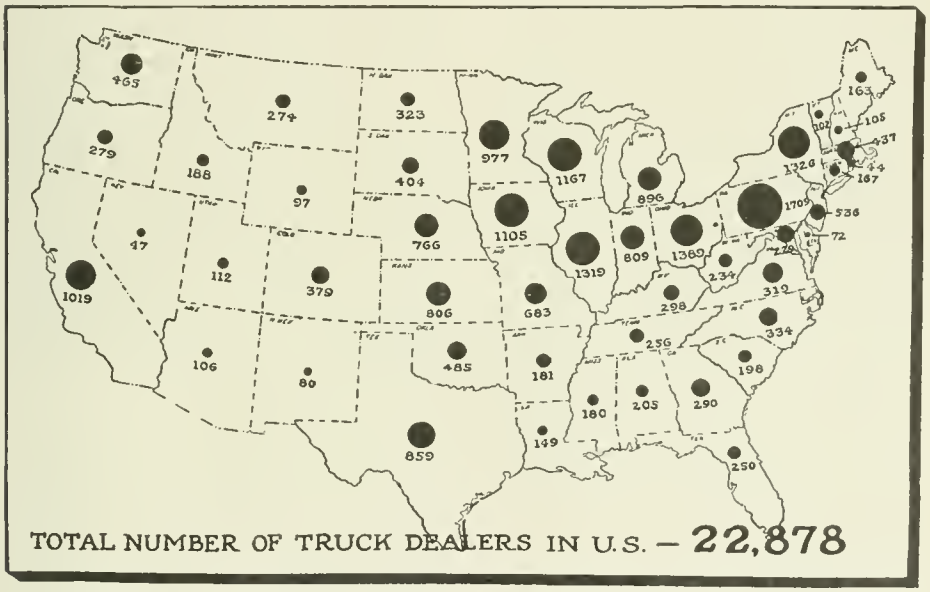
And C. A. Phelan, general manager of the Missouri & North Arkansas R. R., says:

"There is no question but what the motor truck is a great asset in the handling of freight to and from the railroads to the interior country, and there is an opportunity for considerable development along such lines in this country."

This is the picture of the future of truck transportation: a network of lines leading from railway stations and terminals, carrying freight to the roads, and serving interior points which the roads themselves can not reach; plus a great number of short motor express routes carrying goods more economically than the railroads can haul them. The National Automobile Chamber of Commerce estimates that there are about 1,500 motor express lines in operation now in various parts of the country, of which 984 are listed at the N. A. C. C. offices.

A. J. Brosseau, president of the Mack Truck Co., recently told the Merchants' Association of Greater New York how the motor truck reached its present place in our transportation system, and how it will continue as an aid to the railways:

"It is only within five or six years that the motor truck has been an important element in transportation," he said. "It owes its present important position in transportation to the railroads which were unable to handle the enormous volume of freight traffic moving during the boom of 1917 to 1920.



DIAGRAM, BY CHILTON CO., SHOWING DISTRIBUTION OF TRUCK DEALER ORGANIZATIONS IN THE UNITED STATES. NOTE REMARKABLE CONCENTRATION IN NORTH CENTRAL STATES.

"When the railroads became congested and declared embargoes and were blockaded for weeks at a time, manufacturers were faced with the alternative of shutting down for want of raw materials and supplies, or finding another means of transportation. They turned to the motor truck as a temporary substitute. It served them so well that they have continued to use it since the railroads have succeeded in clearing up the traffic jam after the present business depression developed a year ago. Merchants and farmers were also compelled to use the motor truck to move their merchandise and foodstuffs, and they also have continued to avail

themselves of motor truck transportation over the highways.

"As you all know business has been poor for the last year, and the railroads can now handle all the traffic that offers. We are asked if the railroads are now helped by the motor truck. My answer is 'Yes,' for business is going to be good in the near future, and when it is the railroads will again be unable to handle the traffic. We shall then have delayed shipments, embargoes, blockades, and the truck will again save the situation for the railroads and for the public. It may also save the railroads from the fate they so narrowly escaped during the last traffic jam—permanent government ownership."

Mr. Brousseau quoted W. J. L. Banham, a traffic expert, as follows on the economics of the use of the motor truck:

"Users of motor trucks should consider to what extent they can be operated in co-operation with the railroads for short-haul freight movement. The principles involved are: First, service; second, cost.

"There seems to be no question at the present time that the carrying of less than carload shipments to short-haul points by the rail carriers is not only expensive to the shipper, but is also unprofitable to the carriers. Until recently it seemed to be almost necessary for the shippers to use the rail carriers for the movement of their less than carload shipments to nearby points, regardless of expense and delay, as there did not seem to be any organized effort made by the motor truck operators to take care of this class of freight.

"It is extremely difficult for carriers to figure cost of transportation of package freight hauled short distances and particularly to such points at which they do not have a through car movement. The expense of transferring the less than carload shipments one or more times when moving within 50 miles of the receiving station, and the additional expense caused by the delay of equipment, has been recognized by the Government, with the result that the U. S. Railroad Administratoin during the war ruled that freight destined within a certain radius would not be handled by the rail carriers. It was necessary, therefore, for the shippers to find other means of transporting this class of freight. Motor truck transportation, while still in its infancy at the present time, pointed a way to the shippers whereby their less than carload shipments could be handled not only more promptly, but at a considerable saving both to the shipper and to the receiver of freight alike.

"While it is true that it is almost impossible for the carriers to figure the exact cost of handling short-haul freight, it is equally as difficult for the shippers to ascertain the cost of transporting similar freight. The question of cost brings me to the first part of my subject, and in order to make it clear as to what I mean by costs and what these costs cover, I am going to refer to them as transportation costs. Transportation costs do not necessarily mean less than carload freight rates and motor truck rates, although both rates are a part of the transportation costs.

"What I understand to be a true transportation cost is all expense involved in making a shipment, starting with the boxing, or packing expense, together with handling expense in the shipping department, the loading of freight on teams for delivery to the freight house, teaming charges from the shipping department to the local freight house, and additional labor incidental thereto. To this must be added the less than carload freight rate and additional charge for cartage at the delivery point,with such other expenses that may be caused by requests for tracing, duplication of shipments lost or damaged in transit, entering of claims, checking of freight bills, delay to shipments in transit, and the expense of carrying additional stock to take care of freight in transit when moving via rail carriers.

"All of these costs are properly transportation costs, and are a part of the shipping expenses which are paid either by the shipper or receiver."

In England the railroad companies, less liberal, apparently, than ours, keenly feel the competition of truck transportation, and recently made a drastic attempt to eliminate this opposition. Two important groups of railways, the Northwestern and the Midland, attempted to secure a monopoly of transportation in the areas within which they operate. The trucking interests, after watching the attempts of the railroads to acquire truck lines, decided that the roads intended to stifle competition by cutting rates, thus breaking up the existing highway transport companies and finally diverting traffic back to the railroad lines. They therefore determined to fight the railroads with all their power.

It was necessary under the British law for the railroads to get the permission of Parliament before they could operate as

TABLE 1—RAW MATERIALS USED IN CONSTRUCTION OF CARS AND TRUCKS DURING 1921.

(From Accessory and Garage Journal.)

Iron and steel, tons	1,164,000
Production of iron and steel, 1921 (Iron Age)	36,150,000
Per cent. used in manufacturing cars and trucks	4%
Aluminum, pounds	43,250,000
Production of aluminum, 1920 (American Metal Market)	198,000,000
Per cent used in manufacturing cars and trucks	22%
Copper, pounds	83,425,000
Production of copper, 1921 (Survey of Current Business)	510,000,000
Per cent used in manufacturing cars and trucks	16%
Tin, tons	12,510
Total consumption of tin ,1921 (American Metal Market)	60,000
Per cent used in manufacturing cars and trucks	20%
Lead, tons	6,670
Production of lead, 1921 (American Metal Market)	390,000
Per cent used in manufacturing cars and trucks	1.7%
Nickel, pounds	3,400,000
Leather, upholstering, square feet. Total production of upholstering leather, 1921, estimated by the Tanner's Council at 54,000,000 square feet, but of which only 35,000,000 square feet was suitable for upholstering automobiles.	37,165,000
Upholstering cloth, yards	5,357,000
Imitation leather, square feet	88,400,000
Lumber used in manufacturing cars and trucks, feet	313,800,000
Glass (mostly plate glass), square feet	16,500,000
Production of plate glass, 1921, approximately	55,000,000
Per cent used in manufacturing cars and trucks	30%
Top and side curtain material, yards	15,330,000
Hair and padding, pounds	16,000,000
Paint and Varnish, gallons	5,900,000

truck owners, except at their own terminals. They already had the right to collect and deliver freight by truck, but not to transport it by highway exclusively. The truck interests, consisting of truck manufacturers, road transport companies and general industrial undertakings employing trucks, combined to bring pressure to bear upon Parliament to refuse the request of the railroads for extension of their franchises. After a struggle the truckmen were successful.

According to Automotive Industries, a similar situation may develop in the United States, especially in California; and the magazine implies that the truck interests in this country ought to form a combination similar to that which was successful in Great Britain, so as to be prepared for all contingencies.

* * *

Observers of the automotive industry believe that this is going to be a record year for trucks. The wholesale value of the truck output in 1921 was $166,082,000; this year it is predicted that production will reach $250,000,000, and that the sale of tires, oil, gasoline, parts, equipment, etc., will bring the total sum spent on trucks up to $1,000,000,000.

Farmers are expected to want more trucks to carry their big crops, for which, it now seems, they will get good prices. The growth in bus transpirtation, which has now got out of the hands of the old rough "jitney" class of operator and into the control of substantial concerns which seek to operate regular lines, will increase the demand. Trucks will be needed to carry coal over comparatively long routes, to help the railroads, whose capacities will be taxed to the limit. It has been computed that coal can be shipped economically by highway over as great a distance as that from Scranton, Pa., in the anthracite section, to New York City, because of the savings effected in loading, unloading and lighterage charges. The coal delivery companies in the cities, who have been idle all summer, will need additional trucks in order to convey the winter's supply to householders.

The 1922 situation in truck production and registration is thus summarized by the Commercial Car Journal:

"Analysis of all existing data indicates conclusively that total sales in the commercial car industry for 1922 will exceed $1,000,000,000, if we total the five principal items: (1) Commercial cars built during 1922; (2) operating supplies; (3) special truck equipment; (4) replacement parts and supplies; (5) service labor.

"About 250,000 commercial cars will be built in 1922. The f. o. b. sales value of these trucks will approximate $250,000,000, or nearly one-quarter of estimated total sales in the motor truck field.

"Gasoline, tires, and lubricating oil are the principal items to be considered under the head of operating supplies.

"Between 1,100,000,000 gals. and 1,200,000,000 gals. of gasoline are annually used for motor truck operation. At an average of 22 cts per gallon, the gasoline bill will total $250,000,000.

"Nearly 5,000,000 tires will be required this year for commercial cars. These will cost approximately $175,000,000.

"About 75,000,000 gals. of lubricating oil at 50 cts per gallon will bring the bill for commercial car lubrication to $37,000,000.

"Sales of truck equipment will consist principally of special bodies, cranes, hoists, winches, cushion wheels, etc. About 200,000 special jobs at an average of $300 apiece will be required this year. Other

truck equipment, costing about $15,000,000, will bring the total of equipment sales up to approximately $75,000,000.

"Replacement parts constitute an increasingly important item of sales in the commercial car field. Sales of such parts in 1922 will total $73,000,000.

"Labor for service and repairs is figured at about $140 per truck per year, which brings the total for over 1,050,000 trucks to about $150,000,000.

"If facts were needed to demonstrate that the commercial car industry is just getting into its business stride, a glance at the growing increases in registration totals for the past few years would dissipate all doubts.

"In 1913 there were 64,000 motor trucks registered. During the period from 1913 to 1921, commercial car registrations have climbed from 64,000 to 1,050,000, an increase of 1,540 per cent. During the same period registrations of passenger cars have increased from 1,159,034 to 9,455,000, or 715 per cent.

"It will be seen, therefore, that the demand for commercial cars has increased at a much faster rate than has the demand for passenger cars, in spite of the fact that the constantly expanding market for automobiles, during the past decade, has been one of the marvels of modern business life.

"Strictly speaking, the commercial car had hardly become a vital factor in industrial life prior to the entry of America into the World War in 1917. The greatest increase in the number of trucks in use has come about during the four-year period since the end of 1917. Hence, a comparison between truck and passenger car business since 1917 brings out the salient facts more clearly.

"Passenger car registrations have increased from 4,805,331 at the end of 1917, to 9,455,000 at the end of 1921, an increase of 96 per cent. During the same period commercial car registrations have grown from 289,000, at the end of 1917, to 1,050,000 at the end of 1921, or 263 per cent.

"If we scan the above figures, we note that during the past four years the number of commercial cars in use has increased nearly three times as fast as is the case with passenger cars, in spite of the fact that during 18 months of this period the country witnessed the worst business depression in a decade."

The automotive industry is at present in a competitive condition which no other industry parallels. The heaviest competition is in the manufacture of passenger cars; but this affects truck production also, for the big concerns in the passenger car business also make trucks, and their truck costs and output are certain to be affected by conditions in the other branch.

The condition of the automotive industry can best be represented graphically by two pillars resting on a single base. The base is the cheap car, made by Henry Ford and a few minor competitors. Rising about it are two parallel piles, representing the car manufacturers in the higher price classes. One pile represents the General Motors Corporation, whose business is built upon the theory of "one car in each class." On the other side are competing manufacturers in each class—Durant, Studebaker and the rest.

Competition between the two sides is terrific. Not long ago a price war was started which, it was expected, would last for a long time, each side successively cutting under the other. The first cuts have been made by General Motors and by its chief competitors; but further slashes have not yet been forthcoming, and the opinion in the trade is that after those manufacturers who are out of line with present prices have made their cuts, the slashing will end for the present.

"The condition of the trade is thus summarized in The Bache Review:

"One of the phenomenal developments in the revival of business which has been proceeding during the present year, is the long leap ahead of output in the automobile industry. Recently, reduction in some motor prices has stimulated sales, but has not greatly reduced earnings, by reason of the larger production. The cut was intended to speed up sales. Not all manufacturers joined in the price reduction, and those who did not, report practically no falling off in their sales.

"July is usually a month of seasonal decline in output, but production this year exceeded that of July, 1921, by 39 per cent, and that of July, 1920, by 20 per cent. This July output constituted the record figure in automobile production for the month of July, but further than that, only two other months (May and June of this year) have, in the history of the industry, shown a greater output.

"This, it seems, is the very antithesis of what might be expected to happen if times were hard. To date, the railroad and coal strikes have had little or no effect upon the automobile business. A long continuation, which is doubtful,

Tarvia

For Road Construction Repair and Maintenance

Main Street, Harlingen, Texas
Tarvia surface treatment since 1920

Along the Rio Grande—

Twenty-five years ago the Rio Grande Valley, in southern Texas, was an arid, desert waste. Today it is called the "Winter Garden of America."

Irrigation, which the courageous, resourceful settlers secured by pumping water from the Rio Grandé, has transformed the stretches of barren sand into fertile farms and plantations. And good roads, which have been obtained by surface treating the natural caliche and adobe gravel roads with Tarvia, bring the diversified crops, worth millions of dollars annually, within easy reach of the railroads and markets.

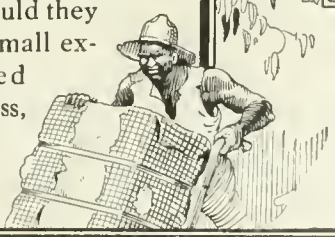
In the Valley are thriving towns, the largest of which are Mission, McAllen, Mercedes, and Harlingen. Here, too, the broad Tarvia-paved streets give unmistakable evidence of prosperity and sound, substantial growth.

In selecting Tarvia for all their road-building and road-maintenance work, these far-sighted pioneers showed characteristic good judgment. For with no other material could they have converted, at such small expense, their unimproved roads into smooth, dustless, mudless, all-year highways.

Avenue of Palms, McAllen, Texas
Tarvia surface treatment since 1919

Texas Avenue, Mercedes
Tarvia surface treatm't since 1919

LaLomita St., Mission, Tarvia surface treatment since 1919



Tarvia is a dense coal-tar material. It is unequaled for building new roads, for resurfacing worn-out macadam, for repairing and maintaining improved roads of every type. Special grades are made for specific uses.

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would, however, affect producton—but not the demand.

"In the earlier years when automobile buying was pounding along at a great rate, there were quite a number of wise people who pointed out warningly that at the rate at which automobiles were being bought, there would some time, perhaps soon, come about a situation when the world would be so full of automobiles that no more could be sold. This was confidently predicted. The term 'saturation point' was adopted in automobile literature and has been used for years. It is, however, misleading. Most people take it to mean that period when, having reached the peak of production, cars are being built only to replace those already in use. This, in itself, is also misleading, as we can never reach such a truly balanced condition. There will always be new buyers—that is, buyers who have never before owned a motor car.

"If 'saturation point' means simply the peak of production, it would be a movable point and would last only for a limited period. This is because population and miles of good roads are constantly increasing and more and more automobiles will be used, barring the almost remote possibility of some other method of locomotion being developed that is cheaper and safer, and also barring political and financial disaster.

"It seems reasonable to presume that if the country continues prosperous in a fair degree and this prosperity is well distributed, a minimum average of 2,000,000 cars per year of all kinds can be safely marketed over a period of five years. Then, if conditions remain the same, there ought to be a fair increase from time to time thereafter.

"Statistics show that the population increases on the average about 1,000,000 a year, and out of this increase there will always be a certain number of new buyers. In addition to this, there will always be a number of new buyers among the present population who have not before owned a car.

"Undoubtedly the world will continue to transport itself from point to point on wheels that are motor propelled, and it would be a brave man who would attempt to prophesy the total number of motor cars that can be used in the United States at any one time. But it is not out of the possibilities to believe that in the next 20 years there will be 25,000,000 cars in use in this country alone.

"In the great industrial activity which is taking place, there has been some question whether the high cost of material, and especially of labor, has not made profits in many lines very small or wiped them out altogether. This, however, from the best information we can obtain, has not been the case in the automobile business. Profit, we understand, has not been reduced on account of labor and material costs, as profits in many instances have never been so high per car or per dollar of investment as is the case at present. Many companies bid fair to make more money this year than ever before in their history.

"The prospects for automobiles this fall are estimated to be emphatically good if strikes are settled and there is no injury to crops. As to next year's prospects, it is believed that about the same quantity ought to be produced as this year but at lower prices, and probably with correspondingly lower profits. But even so, it is thought that this will not be an undesirable condition, as many companies made an abnormal profit per car this year and one that they can hardly justify except on the theory that one is entitled to all that one can get."

DON'TS FOR TRUCK DRIVERS

To insure better care of its motor trucks by their drivers, one company operating a fleet of Republic trucks keeps the following list of "Don'ts" posted in a conspicuous place on their loading platform.

Don't try racing with a touring car; your truck was built for strength, not for speed.

Wash your truck frequently; a dirty car can spoil a lot of our advertising.

Street car tracks are nice on springs, but hard on tires and steel costs less than rubber.

Don't neglect a loose part, even though it seems to operate more freely that way.

Don't forget to watch the other fellow ahead; a slow stop on your part nearly always costs you a punctured radiator.

Use your brakes when getting "spotted"; platforms were built to load from not for bumping posts.

Don't drive too close to the curb; edge-trimming is a fine institution for pie crusts, but too expensive for truck tires.

The steering wheel is vastly important, but it is well also to give the grease cups an occasional turn.

Don't slide the rear wheels when stopping; rubber pavement polishers are too much of a luxury.

Contracts Awarded

ROADS AND STREETS.

Ala., Camden—Lawler & Humphries, Ridgeland, S. C. awarded contract by State Hwy. Dept. for 12.5 mi. gravel road on Camden Greenville Hwy. at $151,492.

Ala., Selma—Worthington & Co., Birmingham, awarded contr. for 4.82 miles road, Dallas Co., plain conc., for $139,697.

Ark., Clarendon—J. A. Perdue & Co., Pine Bluff, Ark. awarded contract by Monroe Co. Commrs. Rd. Impvt. Dist. No. 3, for 18¾ mi. gravel rd. bet. Clarendon and Helena, connecting Phillips and Monroe Cos., via Blackton and Marvel, at $212,000.

Ark., El Dorado—V. E. Schvenell Constr. Co., Memphis, Tenn., awarded contract for street paving and storm sewer constr.; 86,331 sq. yds. 6-in. conc. pavement; 55,600 lin. ft. curb. at $250,000.

Ariz., Yuma—R. Twohey, Phoenix, awarded contract for constr., of 43 miles state hwy. bet. Wellton and Maricopa Co. line, at $161, 374.

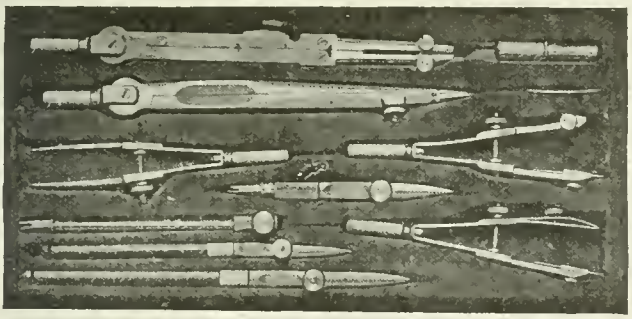
Cal., Los Angeles—Belmont Shore Co., 1015 Marsh-Strong Bldg., awarded contract for constr. of conc. pavement curb, walk, sewer and storm drains on Corona Ave. and other streets near Alamitos Bay, at $116,800, Wm. Liddington, 420 E. 60th St., awarded contr. for paving 1st alley so. of 7th St.—Whittier to Valencia Sts.—at $1,275; W. D. McCray, 416 Am. Nat. Bank Bldg., awarded contract for paving 18th St.—Centro to Patton Sts., San Pedro, at $146,272; Geo. R. Curtis, 2440 E. 26th St., awarded contract for paving Victoria 10th St. to Country Club Dr.—at $23,004.

Cal., Sacramento—Geo. Pollock Co., Sacramento, awarded contract for grading 13.06 miles state hwy. Monterey Co. betw. Anderson Canyon and Sur river, at $786,805.

Cal., Sacramento—W. S. Mead, San Francisco, awarded contr. by St. Hwy. Dept. for 6.8 miles of road to be built in Kern Co., at $281,157; C. B. Christensen, San Francisco, also awarded contr. for 2.7 mi. near Maricopa, at $31,446.

Ga., Lagrange—Davis Constr. Co., Macon, Ga., awarded contr. for 5.5 miles 7-in. plain conc. pavement on Atlanta-Lagrange, Rd., Troup Co., FAP 98, at $132,000.

Ill., Springfield—Following contract awarded on pavement work: Sec. 25, Clark Co. 5.37 mil. to Ralph A. Baum, Paris, Ill., at $116,137; Sec. 164, Cook Co. 1.29 mi. to Chicago Heights Coal Co., Chicago Heights, Ill., at $21,881; Sec. 71, Randolph Co., & Sec. 72, 4.62 mi. to Mautz & Oren, Effingham, Ill. at $95,868 and $102,039, respectively; Secs. 9 & 10 McLean Co., 5.94 & 3.75 miles to R. L. Williams, Wyatt, Mo. at $98,183 and $62,016, respectively; Sec. 19, Sangamon Co., 6.10 mi. to Baker, Agerter & Thompson, Inc., Indianapolis, at $122,-872; S. 12 Lake Co. 4.61 mi. to Darrow & Jacobson, 311 Cory Ave., Waukegan, Ill., at $99,123; S. 17, Kane Co. 0.77 mi. to Jaicks Bros. 275 Thatcher Ave. River Forest, Ill. at $15,694; Sec. 5 & 6, Adams-Brown Cos., to Eiff & Simons, 605 N. 14th St. Quincy, Ill. at $88,529 and $100,560 respectively! S. 1, Jersey Co. 5.36 mi., Nelson Bros. Jerseyville, Ill., at $113,903; Sec. 21 & 22, Logan Co. 4.87 and 5.68 mi. to H. K. Rhoades, Lincoln, Ill. at $88,310 & $100,095 respectively; Sec. 26, Livingston Co.,



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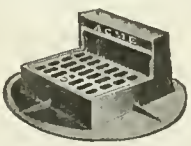

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5 mi. to I. D. Lain, Bloomington, Ill. at $106,112; Sects. 36, 37 & 38D, Iroquois Co. 4.23, 6.60 and 2.90 mi. to McMahan Constr. Co., Rochester, Ind., at $91,223, $120,855 and $51,920, respectively; Sects. 15, 16 & 17, Kankakee and Will Cos., 3.65, 5.63 and 4.04 miles to Rieth-Riley Const. Co. Goshen, Ind. at $67,127, $113,906 and $82,266; S. 11, 12 & 13, Washington & Jefferson Cos., 4.17, 3.40 & 5.15 miles to R. L. Williams, Wyatt, Mo., at $70,907, $59,109 & $96,783 respectively; S. 42, Fulton Co. 5.16 mi. to Sutton & Moore, Canton, Ill. at $120,382; Sects. 66 & 67, Woodford-Marshall & LaSalle Cos., to Ind. Road Paving Co., Bement, Ill. at $93,999 and $95,100; Sec. 45, Schuyler Co. 5.21 mi. to Russell Condon Const. Co., 311 Karbach Bldg., Omaha, Neb. at $122,105; Sec. 2, Carroll Co. 5 miles, C. C. Vanderboom & Sons, Pecatonica, Ill. at $110,943; Sec. 2, Christian Co. 6.63 mi. Baker, Argerter & Thompson, Inc., Indianapolis, Ind., at $135,554. Type for all these sections is Portland cement concrete. State Aid Sections: Sec. E, 35 mi. conc. Bond Co. to Stocker Gravel & Const. Co., Highland, Ill. at $8,761; Sec. K-29A, LaSalle Co. conc., to Ill. State Contg. Co. 2,100 S. Wabash Ave., Chicago, at $19,151; S. N-29A gravel, 1.68 mi. Madison Co. Stocker Gravel & Construction Co., Highland, Ill. at $13,432; Grading Sections: Sects. 29A, 30A, 31A, 33A and 34A, White Gallatin, Saline, Williamson and Johnson Cos., 3.70, 5.48, 5.95, 3.12 and 4.36 miles to Louis Rich Const. Co., E. St. Louis, Ill., at $26,592; $15,023, $14,877, $14,834 and $28,953 respect.; Sects. 35A, 36A and 37A, Johnson Co., 4.14 and 5.88 and 4.13 miles to Buis & Olson, St. Joseph, Mo. at $22,776, $29,038 and $25,485 respect; S. 37A & 32A, McDonough & Woodford Co., 6.06 & 2.99 mi. to J. A. McGaughey Co. 1319 Columbia Ave., Chicago, Ill., at 15,821 and $21,932 respect.; S. 37A, 9A and 10A, Tazewell & McLeanl Cos., 1.76, 5.94 & 3.75 mi. to New Era Const. Co., 6448 Bosworth Ave., Chicago, Ill. at $17,891, $19,640 and $12,667; S. 15A Marion Co. 2.76 mi. to W. C. Whitsell, Mt. Vernon, Ill. at $14,209; S. 4A & 5A, Knox & Henry Co., 3.64 & 3.50 mi. to Cameron, Joyce & Co., Keouk, Ia. at $16,950 and $13,342; S. 30A, Logan Co., 0.67 mi. to J. A. McGaughey Co. 1913 Columbia Ave., Chicago, Ill. at $5,881; Sec. 43A, Fulton Co. 2.94 mi. to Buis & Olson, St. Joseph, Mo. at $24,142; Sec. 44A, Schuyler Co., 0.75 mi. A. O. McCoy, Mt. Sterling, Ill. at $27,539.

Ia., Davenport—Central Engrg. Co., City, awarded contracts for impvt. of four roads as follows: Grading and paving Hickory Grove Rd., at $153,098; grading and paving Durant Rd., $155,904; grading and paving New Liberty Rd., $228,279; grading and paving rd. to LeClaire, $144,486; Lehmer Thompson & McDaniel, Wapello, Ia., awarded contract for rough grading on Hickory Grove Rd., at $14,385.

Minn., Two Harbors—A. Guthrie & Co., Inc., 366 Jackson St., St. Paul, awarded contract for road and bridge work at $650,000.

Miss., Charleston—S. K. Jones Constr. Co., Memphis, awarded contr. for constr. of gravel hwy. with asph. surf., from Phillip to Cowart, distance of 19 miles, at $200,000.

Mont., Missoula—Sims & Carlson, Spokane, awarded contract for road work here at $167,000; Sam Boudry, Clarkston, contract for bridge work, Lolo Pass Hwy.

Neb., York—Roberts Constr. Co., 1st Natl. Bank Bldg., Lincoln, awarded contract for 3 miles of paving in Dist. 20; vit. brk. on conc. base at $3.06 per yd. Approx. $170,000.

N. J., Long Branch—Union Paving Co., 30th & Locust Sts., Phila., awarded contract for paving Ocean Ave.—Sea View to Brighton Aves.—including portions of driveways of intersecting streets or alleys, at $218,000.

N. J., Mt. Holly—Union Paving Co., 30th & Locust Sts., Phila., awarded contract for reconstr. of road bet. Mt. Holly and Medford, conc., at $149,000.

N. J., New Brunswick—Utility Constr. Co., 5 Spring St., awarded contract for paving Albany and French Sts.—Water to Alexander Sts.—$122,644.

N. J., Woodbury—Pub. Service Production Co., 80 Park Pl., Newark, awarded contract for constr. of Route 6, Sec. 14, at $169,776.

N. J., Woodbury—M. Staub, Pitman, awarded contract for paving Paulsboro-Gibbstown Rd., at $92,084; J. F. Burke, 309 Park Ave., Plainfield, awarded contr. for resurfacing Sec. 1, Glassboro-Westville Rd., conc. at J. E. Burke, 309 Park Ave., Plainfield, at $43,497.

N. Y., Buffalo—Rock Asphalt Co., Morgan Bldg., awarded contr. for paving and repaving Delaware Ave.—the Terrace to Mohawk St.—asphalt, at $45,093; also contr. to same contractor for repaving Hamburg Turnpike from Buffalo Crk. R. R. viaduct to so. city line; sandst. blk. on 8-in. conc., at $175,000.

N. Y., Glens Falls—Jno. L. Hayes Constr. Co., Yonkers, awarded contract for about 6½ miles impvt. on Whitehall-Dresden Center Rd., at $296,915.

N. C., Raleigh—The Luck Co., Sylva, awarded contr. for impvt. of 15.22 mi. State Proj. 888, Yancey Co., at $166,565.

N. C., Raleigh—State Hwy. Comn. let following contracts aggregating in cost $4,750,000: Bertie Co. 7.12 mi. soil rd., to J. F. Mulligan Const. Co., No. Wilkesboro, at $31,191 for rds.; Boney-Hostetler at $20,852 for bridges; Martin Co. 12.36 mi. soil rd. to Jameson Bros., High Point, N. C., at $43,620, for ds.; J. A. Marrow, $34,160, for structs.; Martin Co. 12.36 mi. soil rd. to J. F. Mulligan Co., at $44,333; Batson Cook, West Point, Ga., at $37,845, for structs.; 8.80 mi. hard surf. rd., Durham Co., L. L. Tindell, Waterford, Wis., at $229,620; Dawkins Const. Co., Norfolk, Va., at $79,046, for bridges; Orange Co. 9.87 mi. bet. Almance & Hillsboro to R. M. Hudson Co., Salisbury, at $269,850; Davidson Co., 10.24 mi. hard surf. rd. from Lexington to Thomasville, Hagedorn Const. Co., Thomasville, at $322,832; J. A. Peterson, Montgomery, Ala., at $60,556, for structs.; Rockingham Co. 9.83 mi. rd. bet. Leaksville & Reidsville, Cheatwood-Driscoll, Richmond, Va., at $294,352, Atlantic Bridge Co., Roanoke, Va., at $95,292, for structs.; Rockingham Co. 2.10 mi. penetration macadam rd. from Madison to Mayodan, Geo. R. Martin, Salisbury, N. C., at $59,063; Ashe Co. 11.06 mi. gravel rd. to J. T. Plott, Greensboro, at $98,302, for structs., at $81,324; Surry Co. 2.22 mi. hard surf. rd. from Mt. Airy to Virginia line, Geo. R. Martin, $70,506; L. L. Tindall, at $199,428, for 7.03 mi. rd. bet. Chadburn and Whiteville, Columbus Co.; Southern Willette Paving Co., at $181,824, for 10.64 mi.; C. W. Lacey, Wilmington, N. C., at $147,466, for 8.98 mi. rd. bet. Castle Hayne and Long Creek, Pender Co.; Anson Co. 8.88 mi. hard surf. rd. from Wadesboro to Polkton, grading & conc. base to Lampton & Burks, Louisville, Ky., at $170,753; Topeka top to R. M. Hudson Co., Salisbury, N. C., at $76,171; Mecklenburg Co. 9.55 mi. reconstructed and widening base and asph. top bet. Charlotte and Cabarrus Co. line to Union Paving Co., Phila., Pa., at $222,833; Surry Co. 3.40 mi. hard surf. rd. from Yadkin River to Dodson Rd. to Campbell Constr. Co., Columbus, Ga., at $102,441; Wilkes Co. 4.97 mi. soil rd., J. F. Mulligan Const. Co., at $48,714; E. R. Robinson, Wilkesboro, N. C., at $29,492; Wilkes Co. 2.52 mi. hard surf. rd. to D. J. Brookshire Co., N. Wilkesboro, at $52,150; Cleveland Co. 1.58 mi. from Kings Mtn. to Gaston Co. line, Davis Wilcox Const. Co., at $52,150; Rutherford Co. 15.80 mi. soil rd. to C. R. Willard & Sons, Spartanburg, S. C., at $67,874; J. C. Zobriest, Monroe, N. C., at $13,044, for bridges; Buncombe Co. 7.57 mi. hard surf. rd. from Mine Hole Gap to Henderson Co. line, to Allport Const. Co., Asheville, at $293,577; R. C. Stevens, Asheville, for structs., at $16,693.

Pa., Oil City—D. A. Grant Co., Veach Bldg., awarded contr. for resurfacing 7 streets with asphalt, at $103,292.

Texas, Coleman—Womack Constr. Co., Sherman, Tex., awarded contr. to improve 17.72 miles State Hwy. No. 7; thru Coleman and Santa Ana to Brown Co. line, FAP. 194, at $190,000.

Tex., Sequin—Hayden & Austin, Hill & Marsh Sts., Houston, awarded contract by Guadalupe Co., to surf. 19 mi. State Hwy. No. 19 from Sequin to Bexar Co. line; 1½-in. inverted penetration bitum. topping, at $110,794.

Va., Richmond—Battlesell, Clay & Goode, Danville, awarded contract for extension of hwy. in Drapers Valley—10½ miles, at approx. $205,000.

Wash., Seattle—Olympia Const. Co. awarded contract for Olive Way et al., paving, at $133,065; D. H. Traphagen, contract for paving W. Lander St., at $8,451.

W. Va., Welsh—McDowell Co. Court let following contracts: 5½ mi. rd. from top of Indian Moun-

tain southerly to Albert Bros., Charlottesville, Va., at $203,400; 5¼ mile road toward War, to Walton Sudduth, Bluefield, W. Va., at $219,725—grade and rock surfacing.

SEWERAGE AND SEWAGE TREATMENT.

Ark., El Dorado—V. E. Schevenell Constr. Co., Memphis, Tenn., awarded contract for constr. of storm sewer and street paving at approx. $250,000.

Ont., Ottawa—Dominion Lock Joint Co., Hamilton, Ont., award. contract for constr. of sewer, at $80,000.

Fla., Lake Worth—Bunker & Lockman, Lake Worth, awarded contr. for San. Sewerage system and septic tank, Sec. 1 and Sec. 2, at $47,368 and $42,345, respectively.

Ky., Madison—Moreno-Burkham Constr. Co., St. Louis, Mo., contract for constr. of san. sewer system, at $65,400.

Mass., Boston—Following contracts for sewerage works let by city: Jos. Todesca, at $3,013, for wks. in Louder's Lane; DeChristoforo & Bros. Co., at $2,903, for works in Broadway; V. Barletta, at $11,979, for works in Allston St., Brighton; A. Cefalo, at $7,884, for works in Breck Av., Brighton, also works in Centre St., etc., West Roxbury, at $16,423; C. & R. Constr. Co., at $28,492, for works in Hereford St., city proper; Geo. J. Regan, at $12,920, for works in Savannah Av., et al., Dorchester; Bryan & Co., at $25,296, for Spring St. brook conduit in Centre St. and private land, W. Roxbury.

Mich., Detroit—J. Porath, 745 Griswold St., Ashland Ave. Sewer, Sec. 1, $331,951; A. Tobin, 449 W. Columbia Ave., Ashland Ave. Sewer, Sec. 2, $276,439; Jeynes & Affeld, 1208 Ford Bldg., Clark Ave. Sewer, Sec. 5, $238,362; Connelly Bros., 610 Lincoln Bldg., Euclid Ave., Arm Bates St. sewer, $56,556; Holbrook Ave., Arm Bates St. sewer, $47,182; W. Porath, 1410 W. Grand Blvd., Montcalm Ave., Arm Bates sewer, at $10,917.

N. J., Newark—O'Gara Constr. Co., 242 Market St., awarded contract by Passaic Valley Sewerage Commrs. for sewer connection, at $74,150.

Pensauken, N. J.—Jno. M. Kelly Contg. Co. awarded contract for sewer system here, at $179,468.

N. Y., Brooklyn—Following contracts let: D. Bonnacci, 672 Degraw St., relief sewers in Pitkin Ave., $20,047; N. Y. Ave.—E. N. Y. Ave. to Empire Blvd., $14,246; E. 39th St., $9,029; 18th Ave., $6,894; N. Y. Ave.—Midwood to Hawthorne Sts., $2,613; Ridge Blvd., $2,536; Nazzaro & Quierriero, 6712 11th Ave., E. 13th St., $5,863; to S. Ambrosio, 1016 60th St., 55th St., $4,566, sewer basins on southwest cor. Foster Ave. and E. 26th St., $401; n. e. cor. Ave. K. & E. 8th St., $326; Murphy Bros., 262 Bay 43rd St., relief sewer in Croamer St., $3,793.

N. D., Fessenden—Haggart Const. Co., Fargo, awarded contr. for sewer sys., at $40,000.

N. Y., New York—Patrick McGovern & Co., 50 E. 42nd St., awarded contracts for san. sewers and reconstr. of existing sewers in Carmine St., etc., at $235,000.

Ohio, Lima—J. W. Farley Const. Co. awarded contract for Main St. sewer and McHugh & Cole, contract for constr. of Bellefontaine Ave. sewer, at $599,121 and $141,478, respectively.

Okla., Tulsa—Standard Paving Co. awarded contract for constr. of outlet sewer (storm) for Kendall Dist. Way, at $115,333.

Utah, Ogden—Wheelwright Constr. Co., awarded contract to construct storm sewer along 40th St., at $54,499.

Wis., Milwaukee—Knowles-Fehr Co., Chicago, awarded contract for laying sewer thru Esterbrook Park at $149,301; 4,872 lin. ft. 42-in. conc. sewer, 206 vert. ft. of stand. manhole and an 18 in. cast iron syphon.

Wis., Milwaukee—Wenzel & Henach Co., 408 27th St., awarded contr. for intercepting sewer, at $269,183.

WATER SUPPLY AND PURIFICATION.

Cal., Sacramento—Mathews Const. Co., Sacramento, awarded contr. for filtration plant, at $770,-951.

Cal., Santa Rosa—Butte Electrical Equipment Co., 530 Folsom St., San Francisco, awarded contract for constr. of artesian well, rein. conc. aerator flume, receiving reservoir with 350,000 gal. capy. pumping bldgs., compressors, motors, crane, pumps, meters, elec. machy., etc., at $45,000.

Ont., Timmins—Leo. Mascioli, Timmins, awarded general contr. for const. of sewers and water mains, at $40,000.

Ont., Woodbridge—Standard Const. Co., Mimico, Ont., awarded general contr. for water works system, at $30,000.

Fla., Orlando—Following contracts let: Renovating and enlarging water plant: Cranes to Arlington Eng. Co., Euclid, O., $2,500; condensers to D. H. Wheeler, N. Y. City, $11,560; wiring to Johnson Elec. Co., Orlando; boilers to Springfield Boiler Co., 1901 E. Cap. Ave., Springfield, Ill., at $27,114; superheaters to Power Specialty Co., 111 Bway., N. Y. City, $4,100; stack to Rust Eng. Co., Atlanta, Ga., $3,360; steel tank to Chicago Bridge & Iron Co., 105th & Throop Sts., Chicago, $3,360; cleaning water mains to National Co., New York City, $8,384; pumps to Morris Mach. Wks., 41 Cortlandt St., N. Y. City, $4,785; filtr. equipment to International Filter Co., 38 S. Dearborn St., Chicago, at $17,446; valves to Ludlow Valve Co., Ft. Adams St., Troy, N. Y., $5,553; fire hydrants to Columbia Iron Wks., 811 Boyce St., Chattanooga, Tenn., $2,784; water meters to Gamon Meter Co., 282 South St., Newark, N. J., $17,882; Venturi meter to Simplex Valve Co., 5722 Race St., Phila., Pa., $1,048; water pipe to U. S. Cast Iron Pipe Co., 71 Bway., N. Y. City, cost to be determined by amt. used.

Fla., Quincy—Burford, Hall & Smith, 3rd Natl. Bank Bldg., Atlanta, Ga., awarded contr. for improving water and light plant, at $40,000.

Ill., Martinsville—Foulkes Contg. Co., 705 Ohio St., Terre Haute, Ind., awarded contract for 8 miles 4, 6 and 8-in. cast iron mains, including valves, spcls. and fire hydrants, at $54,363.

Md., Baltimore—Frank Carozza, Continental Bldg., awarded contr. for constr. of high serv. reservoir on Reistertown Rd., 20,000,000 gal. capy., at $116,232.

Mich., Bay City—J. L. Sparling Co., awarded contract for constr. of substruct. for filtration plant for city's new water works, at $463,200; contract for superstruct. let to Bay City Stone Co., at $167,-900.

Minn., Thief River Falls—C. M. Carlson, Thf. River Falls, awarded contract for 1,000,000 gal. capy. filt. plant, including plant bldg. and motor house, at $19,100; filter and pumpg. equipt. to J. G. Robertson, 2542 University Ave., St. Paul, at $15,170.

Mo., Eldon—Dwight Chaplin, Wichita, Kans., awarded contract for complete water system, at $64,494.

Mo., Versailles—Burd & Tripp, Hutchinson, Kans., awarded contr. for water works system, at $80,000.

N. H., Salmon Falls—Central Engrg. & Constr. Co., Central Falls, R. I., awarded contract by Salmon Falls Mfg. Co., for bldg. 1 sty. 30x60 ft., brk. and rein. conc. power house and hydro-electric plant, 1,800 h.p. capy., also redevelopment of Salmon Falls. Engr.'s est., $250,000.

N. Y., St. George—N. De Stefano, 257 Glenn Ave., Tompkinsville, awarded contract for water mains in various streets, at $66,669.

N. C., Charlotte—Tucker & Laxton Engrg. Contractors, awarded con for excav. and erection of filtr. plant, at $201,525; Grinnell Co., at $15,303 for gate valves; Southern Engrg. Co., at $26,680, for struct. steel; at $3,236 to Builders Iron Foundry, Providence, R. I., for 2 meters; at $11,372 to Roberts Filter Co., Darby, Pa., for operating tables, dry chem. feed machines and controllers, etc., at $45.50; to R. D. Cole Mfg. Co., Newnan, Ga., for tower and tank, surge tank and wash water tank. Contract for pumps will be let later.

N. C., Kernersville—Boyd, Higgins & Goforth, Charlotte, awarded contract for water works and sewerage systems, at $100,000; R. D. Cole, Newnan, Ga., contr. for standpipe.

N. C., Lincolnton—Boyd-Higgins & Goforth, Charlotte, awarded contract for 6 miles 6-10-in. sewer line, 2 mi. 6-in. water mains, 200,000 gal. conc. reservoir, pump and motor equipment, at $60,000.

Ohio, Cleveland—D. Pfahl & Co., Berea Rd., awarded contract for constructing Impvt. 8 of county water supply system; 25,400 ft. 6-21-in. cast iron pipe to D. Pfahl & Co., Berea Rd., at $88,532.

Ohio, Lyndhurst—Martin & McDace, 1452 W. 98th St., Cleveland, awarded contract for furnishing and laying 10,077 ft. 12-16 ft. cast iron mains, at $51,754.

Pa., Philadelphia—A. P. Smith Mfg. Co. awarded contr. for fire hydrants, at $20,000; Angelo T. Ellis, steel water pipe, for Waynut Lane, Germantown, etc., at $25,000; M. & J. B. McHugh, constr. rail fence and pipe line, etc., at 27th & Indiana Ave., at $25,000; J. Jos. McHugh, laying 33 and 48 in. cast iron pipe lines for Queen Lane filters, at $13,000; A. P. Smith Mfg. Co. contr. for stop valves, at $23,000; R. D. Wood Co., cast iron water pipes as required by Bureau of Water, at $70,000.

R. I., Scituate—Keystone State Constr. Co., 310 S. 13th St., Philadelphia, awarded contr. by Water Supply Bd., Providence, for bldg. tunnel portion of Scituate Aqueduct, at $1,318,340.

S. D., Mitchell—Porett & Tuttle, Mitchell, awarded contr. for 18,000 lin. ft. 6-10 in. cast iron water mains, hydrants, valves, etc., at $34,479.

Texas, Colorado—W. C. Weeks, Arlington, awarded contract for construction of sewers and water mains, at approx. $32,000.

Wis., Benton—Chicago Bridge & Iron Co., 37 W. Van Buren St., Chicago, awarded contract for 30,000 gal. steel water tank on stone tower, including pipe and valve connections; engr.'s est., $25,000.

Prospective Work

ROADS AND STREETS.

Ala., Anniston—State Hwy. Dept., Montgomery, will improve abt. 26 miles of road in Calhoun Co., beginning at Talladega line below Oxford, thru Oxford, Anniston, Piedmont & Jacksonville. Second Div. begins at Etowah line on Gadsden rd. and extends to Reed's Mill, connecting with highway that is being completed by Calhoun Co. from Reed's mill to Jacksonville. Expend about $500,000.

Ariz., Phoenix—About 22 miles on Granite Creek-Tusayan forest highway will be built.

Fla., Miami—Dade County Commrs. will improve roads. $1,000,000 bonds voted.

Fla., W. Palm Beach—Palm Beach Co. Commrs. plan constr. of following roads: Belle Glade to Lee Co. line, $234,000; Belle Glade to Pahokee, $156,000; Bacoms Point to Long Beach, $100,000; Okeelanta to South Bay, $40,000; Torty Isl. to mainland, $35,000; Gardenia to Miami Canal Lock, $4,500; Bacoms Point to Pelican Bay, $5,000; 21 miles bend to sugar mill, $10,000; Military Rd. or connection, $22,000; Lake Worth Rd. and bridge, $35,000; Chosen to Pahokee, $5,000; Okeclanta to Gardenia, $2,000. Considering issuing $650,000 road bonds.

Ga., Forsyth—Monroe Co. Commrs. plan bldg. 10 mi. hwy. from Forsyth to Juliette; also improve National Hwy. bet. Forsyth and Lamar Co. line. E. H. Davis, chf. Civil Engr., Griffin, Ga.

Ill., Peoria—Bd. Local Impvts. considering two street impvt. jobs: W. Virginia Ave.—Elizabeth St. to Garland Ave.—$20,000; W. Armstrong Ave.—Bestor to University—$20,000. Petition has been signed by a number of prop. owners requesting this last named impvt.

Iowa, Marion—Linn County has decided to pave 1 mile on Lincoln Hwy. thru Lisbon. Howard R. Green, Cedar Rapids Savgs. Bank Bldg., Cedar Rapids, will make plans. H. R. Churchill, Aud.

Ky., Whitley City—McCreary County will constr. county's part of Cincinnati-Lookout Mtn., Air Line rd. $200,000 bonds voted.

La., Abbeville—Good roads advocates backing proposed road into Chenier Au Tigre, 40-mile stretch of shell & sand beach front on gulf south of here.

La., Abbeville—$500,000 bonds voted for hard surf. roads in Vermillion parish.

La., Lake Charles—City Council plans 8 miles of paving here which will cost approx. $500,000.

Md., Baltimore—Paving Comn. has estimates on paving roads and streets in new annex.; $12,000,000. Paving in Mt. Wash. section will probably be Rectory Rd.—Wash. Ave. to end of rd; Fairmount Ave.—Rectory rd to end of avenue; Western run rd., from bridge over run to Fairmount Ave.; also repave Hillen St. to North Ave., $100,000; North Ave. to 25th St., $42,000; 25th St. to old city line, $141,000. R. Keith Compton, Chrmn., Paving Comn., City Hall.

Minn., St. Paul—State will expend more than $30,000,000 for good roads again this year. About one-third of amt. will be used on the 7,000-mile state system of trunk highways, and remainder by county and twp. authorities on secondary system. Among items on trunk hwy. budget are 684 mi. extensions of state's sys. of gravel surfaced rds. and 386 mi. grading. In addn. abt. $2,225,000 will be used for maint. an army of more than 1,000 patrolmen, one to mend and smooth each 5 mile sect. State hwy. aid aggregating $2,200,000 apportioned to counties and with nearly $18,000,000 local tax revenues will be used on secondary highways.

Miss., Pascagoula—Board of Supvrs. will ask for bids at October meeting with intention of letting contract sometime in November for bldg. link in Old Spanish Trail. No definite type of pavement decided on and bids for several kinds of hard surf. rds. will be invited. There is available abt. $170,000 for the impvt. General route of new hwy. as agreed upon is from eastern limit of paved rd. in East Moss Point past plant of Southern Paper Co., down to Ala state line.

Mont., Missoula—Stretch of 31 mi. rd. bet. Pablo and Rollings on Flathead Lake, eliminating big Polson hill, is to be constructed as soon after contr. is let this fall as possible. Geo. Labstrum, State Hwy. Commr.

N. J., Newark—Director Raymond, Dept. of Sts. & Pub Impvts., has instructed engineers to push work on paving program. Of a program of some 40 odd streets scheduled for impvt., only 12 are completed. Work Director Raymond desires most to have finished before winter is opening and widening of Bloomfield and Belleville Aves., opening and widening Clinton and Elizabeth Aves., widening of Park Pl., and repaving of Central, Elizabeth, and Clinton Aves.

N. C., Asheville—City Comrs. plan additional munic. impvts.; contemplate $375,000 bond issue as follows: $150,000 for street work; $100,000 for water works; $50,000 for incinerator; $50,000 sewer constr. and $25,000 for fire department.

N. C., Hendersonville—Henderson Co. Hwy. Comn. plans to build secondary and lateral roads on main highway from Buncombe Co. to 5c car line. $590,000.

N. C., Wilmington—City Commrs. plan paving following streets: Market, Castle, Orange, Princess, Chestnut, 17th, 3rd and Ann Sts.; 5th, Wolcott and Perry Aves.

Ohio, Cleveland—County Commrs. have authorized repaving of Detroit Ave., N. W.—West Blvd. to W. 117th St. Est. cost of impvt. $123,000. Co. Surv. Frank Lander. Street will be laid with Medina block.

Ohio, Lancaster—Fairfield County will receive $150,000 fed. aid for extension of impvt. of Cincinnati-Zanesville Rd. Co. Commrs. will put up $200,000.

Okla., Ardmore—It is planned that state legislature at next session be asked to appropriate $100,000 to pay for work which Murray Co. would be required to do in the constr. of new Davis Rd.—Ardmore to Davis.

Tenn., Greenville—$100,000 bonds sold. Will improve and extend streets, etc.

Tex., Alpine—$300,000 bonds voted by Brewster Co. for improving roads.

Texas, Corpus Christi—Nueces Co. will construct 50 miles hard surface road on State Hwy. No. 12; $1,500,000 available. C. E. Cocke, Co. Engr., Corpus Christi.

Texas, Nacogdoches—Nacogdoches Co. plans completing following roads: Hard surf. Mills hwy. extending 16 mi. thru Martinsville and connecting with hard surf. rd. in Shelby Co.; hard surf. Hobby Hwy. from Nacogdoches Co. line at Sacul to San Augustine Co.; hard surf. northern sect. Stone Fort Hwy. from Nacogdoches to Henderson; also plans bldg. following short line hard surf. roads: Tyler, Lower Douglas, Spanish Bluff, E. Appleby; Lozansport; each 4 mi. from city limits; has tentative plans for $600,000 bond issue.

W. Va., Buckhannon—Buckhannon Chamber of

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Com. interested in perm. impvts. to all state roads in Upshur Co. abt. 48 miles; approx. cost $1,500,000. Considering bond issue in connection with state and government aid.

Wis., La Crosse—City will call for bids in October for grading Winnebago St., Mississippi, 19th, 20th, 16th, Barlow, Ferry, West Ave., Horton, 23rd, 24th Sts. Actg. City Engr. Claire Congdon. M. Birnbaum, City Clk.

SEWERAGE AND SEWAGE TREATMENT.

Cal., El Segundo—$200,000 bonds voted for sewerage system here. A. W. Cary, City Engr.

Cal., Los Angeles—Citizens voted in favor of issuing $12,000,000 bonds for constr. of new sewer system here.

Cal., Oakland—Plans prepared for 17,960 lin. ft. 8-in. vit. pipe sewers, etc., in Melrose Acres. W. W. Harmon, City Engr.

Cal., Yuba City—$50,000 will be expended here for sewer system.

Colo., Denver—$32,000 ft. 8-in. and 1,200 ft. 10-in. vit. sewers may be constructed in Berkeley Special San. Dist. $49,000. A. K. Vickery, Engr. City Hall.

Ont., Ford—Plans being prepared for new sewers, $100,000. Prices wanted on materials. M. E. Brian, City Hall, Windsor, Engr.

D. C., Washington—Approx. $750,000 needed to complete the 3 big interceptor sewers which are to free the Potomac River, the Anacosta River and Rock Crk. from pollution. Time not far distant when work must be started on Oxon run interceptor, est. to cost abt. $1,000,000, needed to take care of large area east of Anacosta River which is developing rapidly into a home section.

Ill., Elgin—City will construct modern sewerage system to take care of sewage that now goes into the Fox River.

Ind., Ft. Wayne—Resolutions adopted by Bd. of Works for constr of 7 new sewers here.

La., Shreveport—City will build storm sewers, pavements, re-alarm sys., courthouse, jail, etc., etc. $4,000,000 bonds voted.

Mass., Athol—Appropriation of $60,000 made for general extension of sewerage system of the town; $1,000 for a drain in Kennekung St.; $1,500 for new drain bet. Miller's River and Exchange St.

Mass., Worcester—City Council's sewer committee recommended expansion of city's trunk system: sewer in Greenwood St. and extension of so-called Lincoln St. trunk sewer. Project will cost abt. $200,000. Constr. of sewer in Dorothy Ave., $3,000, and one in Cutting Ave., $3,060, also recommended.

Minn., Amboy—Plans being prepared by Cons. Engrs., Druar & Milinowski, 500 Globe Bldg., St. Paul. Will probably take bids in fall. Wm. Mead, City Clk.

Minn., Pelican Rapids—Prelim. surveys being made for san. sewerage system. Est. cost $40,000. Druar & Milinowski, 500 Globe Bldg., St. Paul, Engrs.

Mo., Parkville—Council has authorized formation of sewer dist. No. 2. Plans and specfs. agreed upon.

Mo., Springfield—G. W. Cullen, City Engr., has begun preparation of plans and specfs. for constr. of sewers in Dist. 41, Sec. No. 2—about 7,800 ft. of sewer.

Ohio, Sebring—Plans for sewage disposal plant here approved by council and will be sent to Columbus for approval by State Bd. of Health. It is hoped to begin work on the plant during the present year.

Okla., Bristow—$40,000 bonds voted here for purpose of improving san. sewer system and $70,000 to construct storm sewer system.

Okla., Sand Springs—Plans being prepared for storm and san. sewers. $90,000 bonds voted. Holway Engr. Co., 329 Kennedy Bldg., Tulsa, Engrs.

Pa., Erie—Revised plans for constr. of extension to east and west side intercepting sewers will be brought to city by J. T. Campbell of engrg. firm of J. N. Chester, Pittsburgh. It is possible public may be asked to vote on $300,000 worth of bonds at Nov. election.

Texas, Electra—City will rebuild sewage disp. plant. Est. cost $12,120.

Texas, Houston—City will expend $250,000 on new san. sewers within a year. Plans being drawn for laying of sewer mains to cost $80,000, and laterals to cost $170,000 will then be put in.

Texas, Lubbock—Plans being prepared for sewage disposal plant and extensions to sewers and water mains. $100,000. Hawley & Sands, Cotton Exch. Bldg., Ft. Wayne, Engrs.

Va., Richmond—City will construct permanent impvts. to sewer system of Shockoe Valley; will construct 2 outlets, one running along 15th St. bet. Hospital St. and the river. Cost bet. $2,000,000 and $3,000,000. Allen J. Saville, Director Pub. Wks.

Wash., Kelso—Plans being completed by Long-Bell Lumber Co., engineers for mammoth storm and san. sewer sys. for their community, which will be built southwest of West Kelso. 1st unit that will be installed will be gigantic storm sewer which will drain entire area of commercial and residential town.

Wash., Tacoma—Resolution passed for storm and san. sewers in entire So. Tacoma Dist. $950,000. J. C. Hanley, City Engr.

Wis., Beloit—City plans 41 miles san. sewers at cost of $450,000. Mead & Seastone, Journal Bldg. Madison, Engrs.

WATER SUPPLY AND PURIFICATION.

Ala., Birmingham—Ala. Power Co. has applied to Fed. Power Comn. for permit to constr. hydro-electric plant on Tallapoosa River in Ala., which will include 4 dams with total capy. of abt. 140,000 h.p.

Ala., Jasper—Jasper Water Co. will install sedimentation and filtering sys. at Lovely St. and 10th Ave. consisting of 2 pumps capable of 110 lbs. pressure, 2 centrif. pumps, one of 350-gal. per min., the other 250 gal. per min., filter, etc.

Ark., Ft. Smith—City Commr. has approved plans for impvts. and extension to water system. Est. cost $500,000.

Cal., Napa—$600,000 bonds voted here, $265,000 of which will be used to purchase sys. of Napa City Water Wks., balance for impvts., including single-arch conc. dam with gravity section, 108-ft. high, 600 ft. long at top, storing 630,000,000 gals. Cost, including control works and spillway, $220,000; pipe line from diversion dam in Milliken Canyon to proposed reservoir, 25,600 ft. 14-in. double dipped riveted steel slip joint pipe, 1,600 ft. 16-in. mach. banded, dipped riveted wood stave pipe, pressure break, valves, etc.

Cal., Napa—Plans being prepared by state for water works sys. for state hospital here. $175,000. State Dept. of Archt., Forum Bldg., Sacramento, Engrs.

Cal., Tracy—Will vote on issuance of $136,000 bonds for constructing septic tank, water main extensions, purchase of fire equipt., etc. W. D. Harrington, Engr., Tracy.

Cal., Williams—Election planned to vote on $50,000 bonds for constr. of water works system. C. E. Sloan, Santa Fe Bldg., San Francisco, Cons. Engrs.

Que., Montreal—Water Works Board plans 12,750 ft. 42-in. steel force main from St. Gabriel pumping station to Clarke Ave. H. A. Terreault, Direct. Pub. Wks.

B. C., Summerland—City contemplates constr. of reservoir of 400,000 gal. capy.; also installation of 6-in. main and hydrants in fire district.

Can., Toronto—City contemplates bldg. pumpg. sta., including intake, pumphouse, filterhouse, filters, pumps, etc., 40,000,000 to 60,000,000 gals. per day. $2,500,000. R. C. Harris, City Engr. and Comr. of Works.

Conn., Berlin—Plans being prepared for extension of water supply sys. Oldershaw & Crowley, 259 Main St., New Britain, Engr.

Fla., Jacksonville—City has accepted recommendation of Jos. E. Craig, Civil Engr., for impvts. to present hard and soft water supply; will construct dam to furnish hydro-elec. power to pump water from St. Mary's River to Jacksonville—25 miles.

Fla., Pensacola—City contemplates expending abt. $93,000 within next year on impvts. to water system. Frank D. Sanders, Commr.

Ill., Gridley—Town preparing to issue bonds in sum of $20,000 for purpose of installing system of water works.

Ill., Minonk—Prelim. steps being taken towards installation of water works system. It is pro-

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truecon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Londers.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

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National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

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W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
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Littleford Brothers.
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Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

posed to issue bonds amounting to $20,000 to finance project.

Ia., Dubuque—Ready for bids soon for pumping sta. impvts. Est. cost $135,000. C. E. Mead & Seastone, Madison. O. E. Carr, City Mgr., City Hall.

Ia., Marshalltown—Plans accepted and will call for bids soon for low lift pumping sta. and pumps to be installed in water field. Engrs., Alvord & Burdick & Howson, Chicago. Anne McMahon, City Clk.

Ia., Wayland—Plans under way for water works; $25,000. W. E. Buell & Co., 205 Davidson Bldg., Sioux City, Engrs. Ray Roth, City Clk.

Ind., Mishawaka—City considering constructing new reservoir with capy. of 1,500,000 gals., installing 3 new high pressure pumps with ability to pump abt. 2,000 gals. water a minute; purchase of over 6 acres land and drilling of several new wells, together with purch. of lines and equipment. from Public Utilities Co. Est. cost of work $125,000. A. R. Klein, City Supt. Water & Elec. Depts. R. L. Baldwin, Hydr. & Constr. Engr., with Burns & McDonnell, Kans. City, Mo.

Kans., Satanta—Vote will be taken on issuance of $30,000 bonds for pumping and distributing systems. $40,000. Ruckel Engrg. Co., Interurban Bldg., Hutchinson, Cons. Engrs.

La., Alexandria—Plans being prepared and city will soon advertise for bids for mains and equipt. for water reservoir. Est. cost $95,000.

La., Bastrop—City will improve water works and electric plant. $45,000 bonds voted.

Mich., Loretto—Plans under way for constr. of power house and dam on Sturgeon River by Peninsular Power Co., Madison (owners). Engrs., Mead & Seastone, Madison. 55 ft. conc. arch dam, 250 ft. long; single vertical unit, 1,000 kw., 60 cycle, 3-phase, automatic sta., transmission line abt. 3 miles long. Will build by day work. $200,000.

Minn., Kenyon—Plans being prepared for conc. reservoir, 300,000 gals. capy., also high service pump. $15,000. O. B. Strand, Vil. Recorder. L. P. Wolff, 1000 Guardian Life Bldg., St. Paul, Engrs.

Minn., Owatonna—City considering constr. of tank, 31 ft. diam., 250,000-gal. capy.; also tower. $15,000. Toltz, King & Day, 410 Pioneer Bldg., St. Paul, Cons. Engrs.

Minn., Winona—Plans under way for pumping sta. Est. cost $260,000. Alvord, Burdick & Howson, Cons. Engrs., 8 S. Dearborn St., Chicago, Ill. Geo. W. Hoffman, City Clk.

Mo., Milan—City will extend water mains and construct filtration plant. $29,000 bonds voted.

Mo., Paris—City will install 2 oil engines, generator and complete equipment for water and light plant. Will probably vote on $55,000 bonds.

Mo., Pilot Grove—Plans being prepared for new water works system. E. T. Archer & Co., 609 New England Bldg., Kans. City, Mo., Engrs.

Neb., Omaha—Plans under way for water works impvts; 4 in. main from Florence pumpg. sta. to Walnut Hill reservoir, 7 miles. $500,000. Owner: Metropolitan Utilities Bd.—W. J. Coad, Chmn. Bd. of Directors.

N. Y., Batavia—City contemplates laying 6-in. mains in 400 ft. Bank St., 750 ft. State St., 500 ft. Hutchins St. 180 ft. Lewis Ave., 900 ft. Walnut St., 300 ft. Walnut Pl., 900 ft. Elmwood Ave., 375 ft. School St., 650 ft. Otis St., 650 ft. James St. 650 ft. Ross St., 1075 ft. Trumbull Pl., 325 ft. Seneca Ave., 500 ft. Eleanor Pl. and 375 ft. Hutchins Pl., $30,000.

N. Y., Canandaigua—City plans to construct mains, including 2½ miles 16-in. pipe from reservoir. $656,000.

N. Y., Dundee—Citizens of village propose to install water wks. system which will include erection of large storage reservoir.

N. Y., Lyons—It is planned to lay 2 miles of 6-in. cast iron water mains from Wayne Co. Home to village and connect with municipal water system.

N. C., Asheville—City considering constr. of impounding reservoir at Bee Tree, storage capy. of about 180,000,000 gals. Est. cost abt. $500,000. Chas. E. Waddell, Cons. Engr.

N. C., Charlote—City will invite bids within 3 weeks for constr. of filtr. plant of 10 million gals. $300,000 available. Wm. M. Piatt, Durham, N. C., Cons. Engr.

Ohio, Greeneville—Water Department contemplates bldg. purification and softening plant. G. D. Hankins, Service Director. Est. cost, $150,000.

Okla., Cushing—City contemplates extending water and sewer systems. $300,000.

Okla., Cyril—City considering extension of water system; will vote on $25,000 bonds.

Pa., Pittsburgh—W. Va. Power & Transmission Co., Pittsburgh, has applied to Fed. Water Power Comn. for permit to constr. 10 sep. developments on Cheat River in West Virginia and Pennsylvania; develop abt. 400,000 h.p.; lower dam and power house to be built near Monongalia-Preston County line.

S. C., Easley—City will extend water and light system; also pave walks. $50,000 paving bonds and $30,000 water & light bonds voted.

Texas, Alvarado—City will improve water works. $30,000 bonds voted for this purpose.

Texas, Austin—City will probably hold election to vote on $400,000 bond issue for impvts. to water sys. Walter L. Eyres, Water & Light Commr.

Texas, Amarillo—Water Board has recommended that surveys be made by Wynkott Kietsted, Cons. Engr., Kans. City, Mo., for water works; surveys to include water wells and damming Palo Duro Canyon and possibly Canadian River. Est. cost abt. $1,000,000.

Texas, Clifton—City considering improving water works. $30,000 available. P. E. Schow, Mayor.

Texas, Gunther—W. R. Huckaby, Van Alstyne, has purchased and will improve water works plant here.

Tenn., Johnson City—City will improve water works system; will vote on $65,000 bonds.

Texas, Shamrock—Atty. General's Dept., Austin, has approved bond issue in sum of $100,000 for water wks. impvts.

Texas, Teague—Plans being made for new water plant. $100,000. E. B. St. Clair, Teague, Engr.

Utah, Clearfield—City considering const. of new water works system. $50,000. Caldwell & Richardson, Templeton Bldg., Salt Lake City, Engrs.

Va., Richmond—Bd. of Pub. Utilities having plans prepared and will soon invite bids for constr. of booster pumpg. stations of 30,000,000 gals. daily capy.; install hydraulic turbines of 1,800-h.p., elec. generators and switchboards and pumps; will also improve water supply in S. Richmond, west of 25th St., including Woodland Heights and Forest Hill sections.

Wash., Camas—Plans being prepared for water works impvts., including 7 miles wood pipe. $40,000. Stevens & Koon, Spalding Bldg., Portland, Ore., Engrs.

Wash., Everett—City purchased 21-acre site for new 3-unit reservoir (one unit to be built at this time). Proposed storage dam will have capy. of 20,000,000 gallons. A. B. Gutter, 3410 Norton St., Engr.

Wash., Spokane—Proposed impvt. of No. Side water system to cost $200,000, including constr. of $80,400 reservoir near Minnehaha Pk., will meet with no opposition from City Council.

Wash., Spokane—Plans being prepared and bids will be taken early in 1923 for pumping outfit, one unit of 1,000 hp., 50,000-gal. per day, housing, 1 well 50 ft. diam., and 55 ft. deep, $65,000; new foundation for pump in old plant, 300 hp. eng., $15,000; 10,000 ft. 6-in. c. i. pipe to replace wooden pipe, $17,500; rein. conc. reservoir, 20,000,000-gal. capy., $14,000. A Lindsay, City Engr.

Wash., Tacoma—City considering laying 20 in. cast iron main from S. 35th St. to S. 54th St.. on portions of J & K Sts.—9,456 ft. 20-in. and 1,392 ft. 6-in. cast iron pipe. $78,757. W. A. Kunigk, 402 City Hall, Engr.

Wash., Tacoma—Bd. of Pub. Wks. plans repairs to water system, including lining one end McMillin reservoir with gunite, lining 300 ft. 48-in. spillway pipe with steel and gunite reinforcing footings; also replacing pipe, involving 1,145 ft. 30-in. cast iron pipe; approx. cost, $51,500. I. S. Davisson, 923 S. 8th St., Engr.

Wis., Baraboo—Improvements to hydro-elec. power plant contemplated by Geo. MacArthur & water wheels, new generator and shrdlushrdlucf Sons, owners. Considering installation of new water wheels, new generator and impvts. to power sta. Mr. Ward, Engr., care Univ. of Wisc., Madison.

Wis., Dodgeville—Contemplates laying water mains and improving pumping sta. Engr. not selected. $25,000.

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Pumps.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
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Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co., The

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

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Austin Machinery Corporation.
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Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Wurrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
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Water Purification.
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The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
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—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

Carey Elastite

TRADE MARK REG. U.S. PAT. OFFICE

PROVED AND ACCEPTED EXPANSION JOINT

Pacific Highway near Bellingham, Washington. The State Highway Department of Washington requires transverse joints at 25 foot intervals. Elastite used.

Elastite Joints never need "re-pouring"

Elastite has proved its efficiency, economy and serviceability in these important installations:

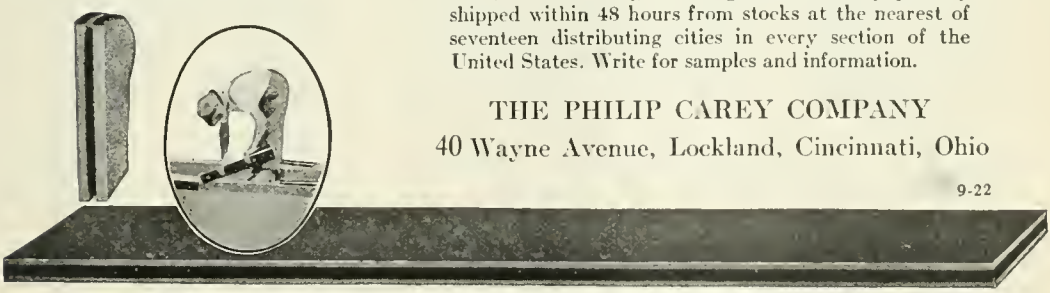
U. S. Marine Corps Roadway, Marine Barracks, Port Royal, S. C.
Utah State Highways
Wisconsin State Highways
New York State Highways
Missouri State Highways
Massachusetts State Highways
Connecticut State Highways
Kansas State Highways
Georgia State Highways
New Municipal Swimming Pool, Johnstown, Pa.
New Sewage Disposal Plant, Milwaukee, Wis.

IT costs one county $20 a mile to *re-pour "poured joints."* This pouring must be done promptly as often as once a year if roads are to be kept in good condition, and to protect the sub-grade from water soaking and frost-injury.

Elastite joints never need "re-pouring" or re-placing. Elastite is a ready-made, frost-tight, water-tight, efficient, durable and permanent joint. Elastite does not melt, run out, or cut out with heavy traffic. The maintenance cost for Elastite is *zero.*

Elastite is a factory-made expansion joint, preformed and ready-to-use. It is a body of tempered asphalt compound sandwiched between two layers of asphalt-saturated felt, comes to the job cut to form, size and thickness, and is installed in one operation.

Made like a sandwich
Installed like a board



Use Elastite for concrete, brick and block pavements, sidewalks, flumes, aqueducts, bridges, viaducts, reservoirs, stadia and large buildings. Orders in any quantity shipped within 48 hours from stocks at the nearest of seventeen distributing cities in every section of the United States. Write for samples and information.

THE PHILIP CAREY COMPANY
40 Wayne Avenue, Lockland, Cincinnati, Ohio

9-22

Water Works Equipment Service

If in the market for any of the following water works equipment, so indicate by check marks, mail this page to *Municipal and County Engineering,* 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
—Air Lift Pumps
—Ash Handling Mach'y
—Backfillers
—Brass Goods
—Chimneys
—Chloride of Lime
—Chlorinators
—Coal Handling Machinery
—Concrete Hoisting Equipment
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—Condensers
—Conduit Rods
—Cranes, Locomotive
—Cranes, Traveling
—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
—Liquid Chlorine
—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead-Lined
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—Pipe, Wrought Iron
—Pipe, Wooden
—Pitometers
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—Pumping Engines
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—Specials, Cast Iron
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NEW YORK STATE

TEXACO Asphalt Macadam on Ulster County Highway No. 16, part of New York State Highway System.

What should be the part of the Asphalt Macadam pavement in a State System of Highways?

—a question of the greatest significance to highway builders.

One reliable and convincing answer to that question is to be obtained from a brief survey of the New York State Highway System.

These facts are pertinent and authentic.

AND

TEXACO Asphalt Macadam at West Point Military Academy, West Point, N. Y.

At the start of the present year the bituminous macadam type was represented on the highway system of New York State to the extent of 3,254 miles. This was equal to almost twice the total of all other kinds of paving combined, with the exception of water-bound macadam of which there were 3,908 miles.

A comparatively low first cost with a reasonable upkeep and a lasting, gratifying service. These are the qualities which have placed bituminous macadam so extensively on the highways of this State.

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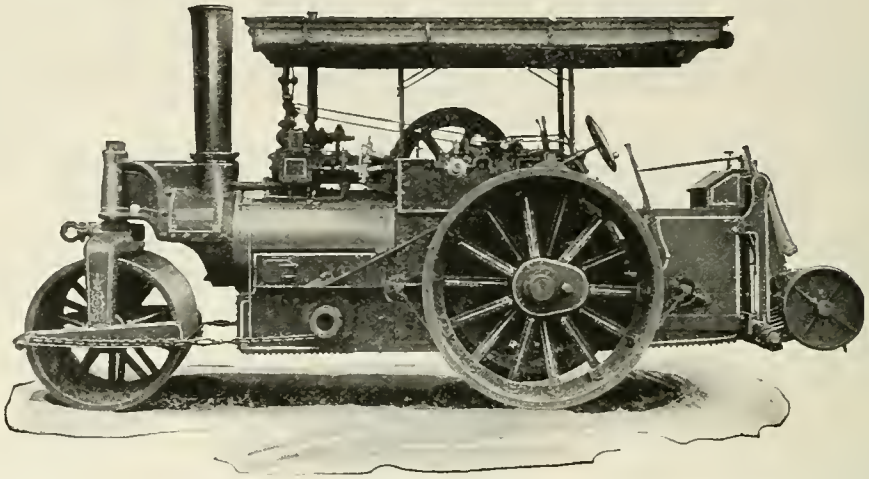

"Buffalo-Pitts" and **"Kelly-Springfield"** render best and longest service. Made in all types and sizes—steam and motor. Buffalo-Springfield Pressure Scarifiers are money-savers and can be furnished with new rollers or attached in the field to rollers already in use.

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FOR CONCRETE ROADS

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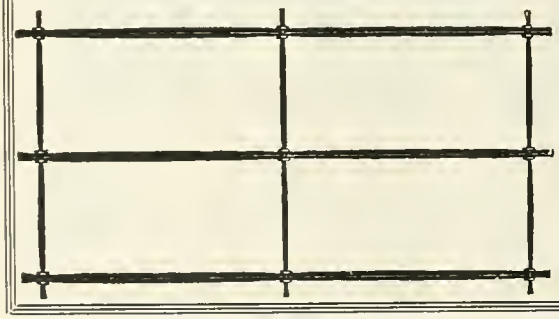

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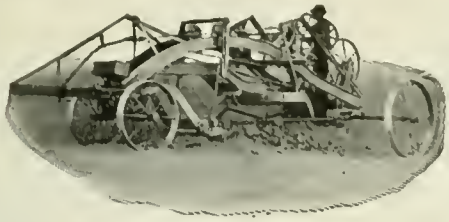


A-W Graders AND GRADER-SCARIFIERS

14 Models

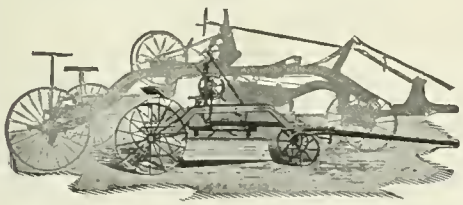
You don't have to look further than the first twenty-one pages of General Catalog No. 21-O to find the machine exactly suited to your needs.

The graders range in weight from the Midget at 1,000 pounds to the No. 20 at 9,000 pounds.

Scarifiers can be attached to all graders of at least standard size, but for a really efficient outfit, choose the Austin Rip Snorter, which scarifies and grades at the same time; or the Western Scarifier, big brother to a grader on the hardest jobs.

It will pay you to read the whole story of Austin-Western Graders.

Send for Catalog No. 21-O.



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Dallas, Texas, after competitive demonstrations, bought three 5-ton "Caterpillars"* in June, 1921, for use in its street maintenance department. These machines proved so economical of time and labor that last April the City added another 5-ton and a 10-ton "Caterpillar"* to its fleet. City Engineer Fairtrace says: "Before we had "Caterpillar"* motorized outfits we could only smooth up our 300 miles of dirt and gravel streets once a year. *Now we are grading these same streets every six weeks, or eight times as often. And our yearly cost of street maintenance has not increased one penny."* Write for our booklet on the "Caterpillar"* in municipal service.

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Reg U.S. Pat. Off.

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*There is but one "CATERPILLAR"—Holt builds it

This is an ideal type of construction for city or town use for several reasons. Usually storm water runs lazily through a town drain pipe because there is not the fall that it is possible to get on a county road. Hence the problem of keeping these drain pipes open is a big one. A 15″ pipe is only about 8″ high, but spreads out right at the bottom to 15″. This allows a full capacity flow right at the start and the smooth flat bottom made of heavy Galvanized sheets doesn't retard the flow of water. Furthermore, the bottom sections are made in 6-foot, 8-foot and 10-foot lengths, which by using separately or combining you can get the short 6-foot length for drainage under sidewalks and any longer length desired in multiples of 2 feet. All top sections come in 2-foot lengths, which is not only a convenient size for handling, but simple to put in or take up whenever necessary. They ship closely nested and take up no space worth mentioning when in storage. Last but not least they are made of 2-ounce spelter-coated "GENUINE OPEN HEARTH IRON" guaranteed 99.875% pure Iron-Copper Alloy.

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A 15-inch Half Round Flat Bottom "Genuine Open Hearth Iron" Culvert.

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The ideal brick pavement filler. Made to meet the strictest specifications. Low prices and immediate delivery on any quantity.

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Owned by those it serves

Less than fifty years ago an application was made for a patent which created the possibility of speech between distant points. It was the culmination of years of study, research and experiment. It suggested a new aid in commerce and domestic life; a new tie to bind the people together. But it was only a suggestion—a dream.

To make that dream come true required the creation of an organization unlike any other. It demanded a kind of scientific knowledge that was yet to be formulated, as well as a type of equipment still to be devised. And it necessitated the financial and moral support of many communities.

Out of this situation grew the Bell System, bringing not only a new public service, but a new democracy of public service ownership—a democracy that now has more than 200,000 stockholders—a partnership of the rank and file who use telephone service and the rank and file employed in that service. The American Telephone and Telegraph Company exists to serve the people and is owned directly by the people—controlled not by one, but controlled by all.

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AMERICAN TELEPHONE AND TELEGRAPH COMPANY

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To neglect the maintenance of any road now may be the direct cause of serious damage before Spring. The expense of repairing such damage is unusually great and is regrettable when considering the cost necessary to avoid it.

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We will be glad to mail you a copy of our booklet "Modern Methods for Maintaining Roads and Streets," showing various styles of equipment suitable for road and street maintenance.

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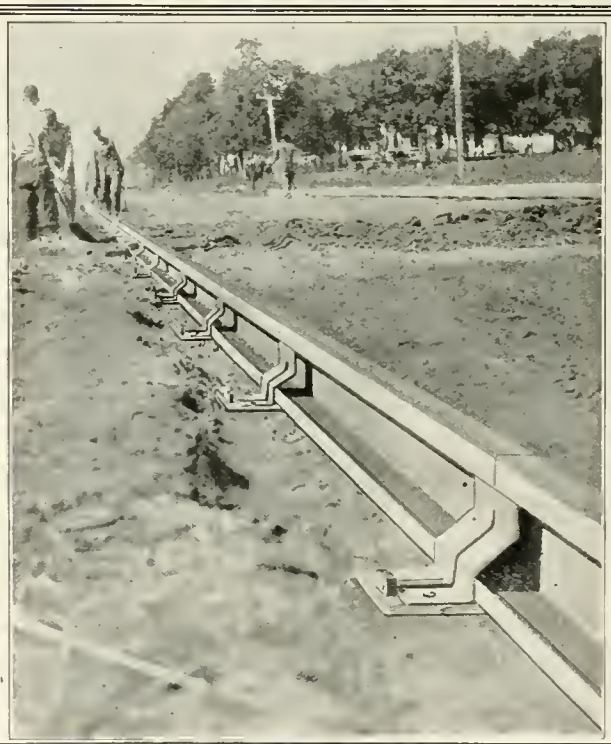

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BUILT LIKE A RAILROAD

Illustration at the left shows the perfect alignment secured with **Heltzel** Steel Forms.

This perfect alignment is a result of **Heltzel** Steel Forms being built like a railroad—a rail, a pedestal and a stake—no keys, wedges or clamps. No right or left hand rails.

Line the pedestals, lay the rails and place them on the pedestals by simply fitting the rail groove over the pedestal flange—fits snug and secure—a perfect joint. Write for a copy of the **Heltzel Blue Book** which gives complete details.

The Heltzel Steel Form and Iron Company

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Largest exclusive builders of steel forms for Road, Sidewalk, Curb, Curb-and-Gutter and all types of concrete construction, and Tamping Machines, Heltzel Hand Strikeoff Tamp, Heltzel Rotary Steel Float, and other accessories.

Will not freeze in any weather

DUMORITE—the new du Pont dynamite which gives you over ⅓ more work for your dollar—is *non-freezing.*

By rigorous laboratory tests and extensive field operations we find that Dumorite can be shot successfully at any temperature. It is just as good in below zero weather as in the summer time.

Stick for stick, Dumorite does approximately the same work as 40% dynamite, but you can buy 135 to 140 sticks of Dumorite at the same price as 100 sticks of "40%." And Dumorite is a guncotton-nitroglycerin dynamite that will not cause headache.

Dumorite is being used successfully in most kinds of explosive operations. Write our nearest branch office giving details of your particular work and let our Service Department solve the problem of fitting Dumorite to your job. Let Dumorite reduce your explosive bills for 1923.

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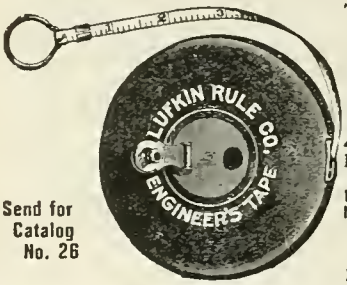

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More of them are in use than all other makes because they have for years consistently maintained the highest reputation

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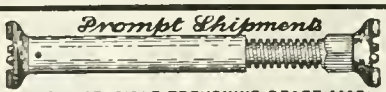

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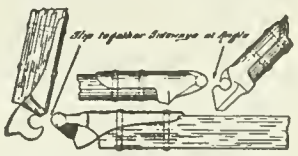

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In cast iron rust never penetrates below the surface; the first layer of oxide which it forms acts as a protection, effectively preventing further corrosion. Should the tar coating placed on all water pipe become destroyed, the metal will, in this way, form its own coating.

For this reason cast iron endures under exacting conditions. The history of cast iron pipe, and it goes back for centuries, has not been long enough to establish a limit.

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STEAM KEYSTONE SHOVELS

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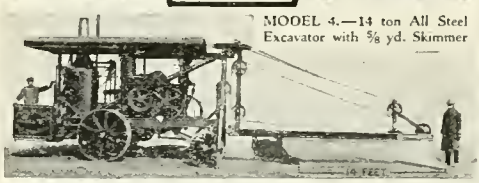

MODEL 4.—14 ton All Steel Excavator with ⅝ yd. Skimmer

The KEYSTONE is a highly versatile traction steam shovel with all the efficiency of specialized design, usable with three different interchangeable scoops—*Skimmer, Ditcher and Clam Shell*—for Road Grading, Trenching, Back-Filling, Cellar Digging, Pit Mining, Loading, Unloading and Handling Materials. Can be equipped with electric motor drive for use in buildings. Saves first cost, moving cost and upkeep and is readily sold or rented for any sort of excavation job. A reliable road shovel of remarkable adaptability to other uses.

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Model 4, with Boom extension and ½ yd. Clam Shell Bucket

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Keystone stands on the solid. No cribbing needed, no danger from cave-in, of machine sliding into excavation. Any width or depth to 20 feet. There is 4 feet of water in this 12 foot ditch. The Keystone is adapted for hard going among roots, boulders, etc., and cleaning out blasted rock.

Keystone Driller Company Beaver Falls, Pa.

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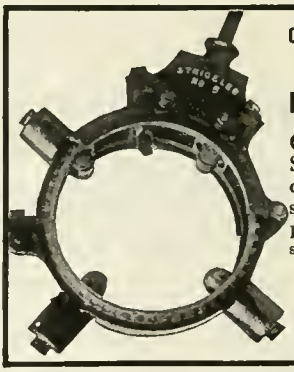
D-4



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Ratchet Pipe Cutter

Cuts either Cast or Steel pipe. Cuts a channel in the pipe same as a lathe cut.

Each size cuts a range of sizes. Catalog on request.

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EDITORIALS

ADVERTISING GOOD ENGINEERING

Engineers frequently complain that the public does not turn to the engineer for his professional services with the same regularity with which it turns to doctors and lawyers for their professional assistance. It is said that when the average man is ill he consults a physician and that when he becomes involved in a certain class of difficulties he immediately engages a lawyer, and that, in either case, he employs the best talent he can afford. On the other hand, it is asserted, that many times where an engineer is needed he is not engaged, and, if engaged, his ability is not always given due consideration. Undoubtedly there is much truth in these beliefs, and it is worth while to consider what can be done about it in the interest of the engineering profession as a whole.

The engineer is in the position of a manufacturer of a good article for which there is a large potential demand, but for which the active demand is not what it should be. In such a case the manufacturer advertises his product to make it better known and to increase its sale. The engineer also has something to sell for which there should be a more active demand, namely, his professional services. The suggestion that he should advertise his ability to render service has been given favorable preliminary consideration.

By advertising, in this case, we do not refer to general activities calculated to bring the engineer to the favorable attention of the public, but formal, group advertising in a popular magazine of large circulation. For the sake of illustrating the idea, let us assume that twelve pages of space be purchased in the Saturday Evening Post and that twelve full-page pieces of advertising copy be inserted in this space at the rate of a page per month for one year. Each page would have a primary circulation of 2¼ millions and a secondary circulation probably three times as great. The cost would be, we are told, about $75,000. The "copy" would be purely of an educational nature, entirely dignified and conservative, and designed to impress upon the public that it pays to employ an engineer when there is an engineering job in hand. There is an old definition of an engineer running as follows: "An engineer is a man who can do with one dollar what anybody can do with two." This might well be made the keynote of the campaign and be elaborated upon to show that it really pays in dollars and cents to employ an engineer when there is an engineering problem to be solved. This would undoubtedly make the public much more familiar, than it is at present, with the ability of the engineer to render money-saving service and would greatly increase the demand for engineers. The increased demand would, of course, be worth real money to engineers.

Here is an investment we should like to see the profession make. Immediately a question arises as to where the $75,000 fund is to come from. That, we admit, is a problem, but not one of such difficulty that its solution appears impossible. It is not unlikely that the American Association of Engineers could collect such a fund from the profession by receiving subscriptions from individual engineers and engineering firms. It might take two years to raise the fund, but that is surely a short period in the life of a great profession.

To any one who says the procedure recommended is unprofessional, undignified, etc., we can only say that if the reputable engineer's code of ethics and his idea of professional dignity will not permit him to make use of the instrumentalities employed by reputable business men, then there is something radically wrong with the engineer's ethics and his conception of dignity. If good engineering is in the public interest, what possible harm can result from telling the public about it?

STATE MOTOR AND HIGHWAY ORGANIZATIONS

While there are numerous organizations of men interested in motors and highways it is doubted that they are of the type best calculated to safeguard and develop highway transportation in all its phases, including, of course, the construction and

maintenance of roads and streets as well as the sale of motor vehicles of all classes, and including, also, the application of the vehicle to the roadway in passenger and freight transportation. There are now so many organizations among the automotive and highway people that the suggestion of new organizations will not be looked upon with favor until the need for them is more clearly understood than it is at present. It is the object of this discussion to call attention to the need for state organizations open to all who are interested in motor transport.

The numerous existing automotive organizations overlap but come far from covering the field of opportunity. They duplicate memberships and membership fees because of their narrow foundations and functions. Some men belong to several of these small organizations, of local scope, while other men do not "join up" at all. As a result there is much waste of time and money, much feverish but futile activity, much running around in small circles, and not so much as might be hoped for in the way of results.

The need for national organizations is admitted, but whether these are too many or too few it is not the present purpose to inquire. It is well to point out, however, that there is not enough affiliation and cooperation between national and local organizations to secure the best results.

Because of the bearing of state laws upon the use and development of highways the state is the proper political base upon which to build up motor and highway organizations. We should like to see in each state one organization made up of men in the automotive trades, men engaged in highway building and maintenance, and, most important of all, the users of the roads and streets. Such organizations can be made great in numbers, in resources, and in political influence.

The user has been overlooked much of the time and this is most unfortunate for users are numerous, wealthy and powerful. The user has a proprietary interest and should be admitted to membership in motor and highway organizations, because of his political influence if for no other reason.

In an average state there are two or more organizations of road promoters, road boosters or road builders, and in every city of consequence in that state there are two or more organizations of men in the automotive trades, and membership in these groups is always representative and sometimes extensive, while the great majority of highway users do not belong to an organization of any kind interested in the construction, maintenance or use of highways. For example, in one state only 10,000 out of 400,000 owners belong to the motor club.

The point to which divisions within the industry may be carried is for the men in the industry to decide; we argue only for united effort to safeguard fundamental, common interests.

There is a great deal of "anti" sentiment being worked up with reference to motors and highways. In 1923 as many as 43 state legislatures will convene and in every legislature one or more bills calculated to regulate or restrict motor traffic, or put it out of business entirely, will be introduced and pushed. The interurban railways make no secret of the fact that they will regulate trucks and busses out of business if they can, through legislation secured for that purpose, and they even propose exorbitant charges on passengers cars. This strikes directly at the highway construction movement itself, which may fairly be said to be under fire. How are the motor and highway interests to meet this attack?

We have given our answer to this question: we should have state organizations open to all road users, road builders, automotive trades people and all others interested in motor transport. Such organizations, if properly put together and well officered, can defeat adverse legislation. We do not consider fair regulation objectionable, in fact, it is to be encouraged, but legislation intended to cripple or kill highway transport must be defeated at all costs.

The highway user is likely to possess much more legitimate political influence than the man who sells motors or builds roads. The latter groups will be classed as purely selfish, whether they are or not, by the legislator, and the same is true of commercial users, but he cannot accuse the general run of business men, who use highways and motors incidentally in the conduct of their business, of being purely selfish for their interest is the very thing that constitutes the true public interest. Into these state organizations there must be brought, therefore, as many as possible of the great number of people who have an incidental interest, as distinguished from a vital, direct commercial interest, at stake in motor transport.

MARKING MANUFACTURED PRODUCTS AS AN AID IN APPRAISAL WORK

By W. Malcolm Lowry, of Henrici-Lowry Engineering Co., Consulting Engineers, 222 Commerce Trust Bldg., Kansas City, Mo.

Many new conditions have appeared within the last few years which have enlarged the scientific appraisal field. The co-insurance clause in fire insurance accounting, the income tax, and refinancing have contributed many requirements which only an inventory and appraisal can satisfy. The war valuations of plants and processes, the liquidation of government contracts, all have made necessary a complete history of the investment. The capital values of plants have not been properly determined in many industries, therefore a physical examination is essential for book accounts. Together with the above belongs the appraisal made for bondholders, the valuation for purchase or sale and the earning level for rate-making purposes.

In any carefully prepared inventory the listing and description constitutes the basis for establishing physical value.

To those who have actually compiled the field notes on a large plant, or have assisted in placing values on a certified inventory, it will be unnecessary to recount the causes for delay and uncertainty occasioned by the inherent lack of description pertaining to all classes of machinery, especially if the appraisal is based on reproducing the plant with similar or duplicate equipment.

The instructions given by our office to all men engaged in listing physical property make it obligatory upon them to secure full data, but in many cases circumstances prevent its accomplishment.

One element of this difficulty can be easily remedied if manufacturers would properly mark all of their products. In a recent appraisal for a steam and electric railway shop a large portion of the equipment was practically without name or number.

Frequently in a woodwork or metal machine shop, various types are encountered without a single mark of identification or name plate.

The writer would respectfully suggest that the manufacturers recognize the duty they owe to the purchaser and assist in making the owner permanently able to establish the usefulness and value of his equipment.

In many pieces of equipment the producer could easily cast into the frame such description as would not become obsolete or incorrect by wear. This could include the name of manufacturer, his address, a serial number, the size of the distinguishing portion such as cylinders of engines, bed plates on planers, limit or size of lathes, maximum range in capacity of shears and presses, areas of manglers, cubic contents of tumblers and separators, capacity of freezers, ice crushers, receivers, description of boilers and other equipment. The above are only random items, and each class could be given a proper classification. On certain classes of special machine design, the duty or classification could well be shown in one word as "Planer."

The casting into the machine of its shipping weight would be extremely valuable, for from this could be worked out a per pound unit.

The year probably could not be used except in cases of machine constructed upon definite sales order.

There are certain disadvantages to such a procedure, but from a large experience it appears that much time could be saved in compiling inventories, if all machinery were marked more completely and in convenient location.

A serial number is generally found on machines of large capacity, but often this is placed on a removable plate attached by screws. The electric motor manufacturers are to be commended upon the manner in which all articles and types of equipment are described and other pieces of apparatus could well be lettered and named. The manufacturer is frequently put to expense in answering letters from engineers asking for just such data as could easily be cast in the main frame.

The writer realizes that many machines are stock manufactured and sold without the factory's regard for permanent advertising or responsibility, hence the lack of identification, but even on such articles a weight could be given which would be of service.

Many valuation engineers have been compelled to prepare elaborate machine schedules in order to overcome this problem, and while most of our offices are now able to distinguish the unknown in the present machines, new processes are continually presenting themselves, bringing along new types of machines which will be hard to estimate in the future.

The owners could also be of great assistance if proper office records were maintained, giving the history of all pieces of

apparatus purchased and installed, but experience shows that many factories are without complete shop data, hence the appraisal.

Only last week our office had occasion to list some equipment and one piece of uncertain age was encountered which required the field engineer to make a detailed sketch in order to secure proper notes.

It is possible that manufacturers have some well-defined reasons for this omitting of such data. However, to the appraisal engineer its appearance would be very welcome.

Should it be possible to let the manufacturers know of the many demands for appraisal inventories, it is probable that they might all consent to these little refinements to their machinery and equipment which would be of lasting benefit.

It is hoped that the future appraisal engineers will find all new equipment permanently and properly marked.

STANDARDS AND STANDARIZATION WITH SPECIAL REFERENCE TO PAVING BLOCKS

By George W. Tillson, Consulting Engineer, 518 So. Catherine Ave., La Grange, Ill.

So much has been written during the past few years upon standards and standardization that it might seem almost futile to say anything upon these subjects at the present time. It may be possible, however, to state a few facts in such a way that they will be of some benefit.

A standard is a model, something that can be profitably copied. It follows, then, that the standard should be set up only by one who is a recognized expert on his particular subject. Some years ago the bridge specifications of Theodore Cooper were generally admitted to be standard, as it was well known that Mr. Cooper was past master in the knowledge of bridge construction and of the requirements of the materials used therein.

When a motor was desired for the use of American airplanes in the World War, experts, not simply in motor construction, but experts in each particular part of a motor, were called in so that the completed product was one that was standard and perfect according to the knowledge of that time.

There is little doubt that if all automobile industries in this country were under one control and the best design for each particular type of car were used by all factories the cost of automobiles would be materially reduced. One object, too, of standardization is to set up a model that will serve as a copy to those who wish to produce a certain result, but have not the particular knowledge to effect it.

One point must be considered here. A standard is supposed to be the best of its kind. But in practical work what is theoretically the best is not always economically so. The writer was once called down quite severely by his professor in college when in an essay on "Foundations" he made the statement that rock makes the best foundation, the professor's argument being that oftentimes sand is as good as rock.

Granite Block.

Perhaps the greatest care in using or making standards is necessary in specifications for public work. Some 12 or 15 years ago the municipal engineers located in and near New York City met together with the producers of granite paving blocks to see if they could not agree upon a uniform size for these blocks. It had been found that the called for sizes of granite blocks in New York, Philadelphia and Boston, while practically the same, differed enough to prevent the use in one city of those manufactured for another. The ill effects of this can easily be seen. A granite man might have a surplus of Boston blocks when there was a large demand for blocks in New York which he could not supply, and the same might be true of Philadelphia.

Besides obtaining a uniform size the engineers wanted a better block. They recognized the fact that the public was calling for better stone pavements and were ready to pay for them. The producers were called in to ascertain what effect certain changes in dressing and uniformity in widths would have on prices. They knew that it would be easy to specify a block so dressed and so laid as to produce a perfectly smooth pavement, but its cost would be prohibitive. What was desired was to know just how far they could go with their requirements without making the expense too great. The best granite pavement the writer ever saw was laid in Glasgow, Scotland, in 1913. The blocks were uniform in size and dressed upon every side but the bottom. The top was smooth. The pavement laid complete cost $5.25 per sq. yd., which before the war and in Scotland was a very high price.

The result of this conference produced a block that was very generally adopted. Shortly after this the organization for standardizing paving specifications was

perfected and carried on the work. This society later merged with the American Society for Municipal Improvements, and this latter organization is now studying specifications for all municipal work and revising them when necessary. But, as has been stated before, these specifications must not be followed blindly. They can, however, always be depended upon to give good results, but it may sometimes be at too great cost. Certain grades of stone may be specified, when local stone, not perhaps fully up to the standard, may be used with satisfactory results. A good instance of this can be seen in the roads constructed by the New York Board of Water Supply around the Ashokan reservoir, a few miles west of Kingston, N. Y. These roads are nearly all of asphaltic concrete laid upon a broken stone base. There was an unlimited amount of hard sand stone in close proximity to the work, but of course it would not stand the tests required of stone in standard specifications. The cost of trap rock would have been very great, and accordingly it was decided to use the local stone. The results have certainly proved the wisdom of this course.

Paving Brick.

In the manufacture of paving brick there has probably been a greater diversity in sizes and styles than in almost any other industry.

At a conference of engineers, manufacturers and others held at the Department of Commerce, Washington, last November it was shown that there were 66 different styles of bricks being used in street pavements, the manufacturers either working according to their own ideas or the whims of engineers who had not given the matter careful consideration. The importance in having paving brick of uniform size is greater than in the case of granite blocks, as brick plants are so much more numerous and scattered over so large an area of country. Bricks of the same quality shall be interchangeable no matter from what plant produced. This is necessary not only in case of an unexpected shortage in construction, but also in making repairs. This conference gave the matter careful consideration. It was made up of state, county and municipal engineers, representatives of nearly all of the paving brick manufacturers of the country, representatives of the Department of Commerce, as well as others interested in the subject. The result was that a resolution was adopted recommending that the 66 styles be reduced to 11 specifically described in the resolution, and at a subsequent meeting the number was reduced to seven.

The meeting felt that, while it had no power to enforce its findings and could only recommend, the effect of such action by such a body would be immediate and must bring good results.

The writer has always been strongly in favor of standards and standard specifications, but wishes to reiterate what he has previously said that they should be used understandingly with a knowledge of why this thing or that is required, so that any omissions or additions may be made without producing a document that would be inconsistent and of little value.

THE WAREHOUSE AND ITS RELATION TO HIGHWAY TRANSPORTATION

By Russel N. Edwards, Engineer and Architect, 16 Union Trust Bldg., Indianapolis, Ind.

(Editor's Note.—The present article gives the views of an engineer as regards the requirements of the future warehouse and its relation to transportation, distribution and business problems, as presented to the members of the Indiana Transfer and Warehousemen's Association.)

The relationship of the warehouse to transportation, distribution and business is well illustrated by our postal system. When a manufacturer in Indianapolis desires to communicate with his jobber in Laporte, he writes a letter, places the required postage thereon and mails it. He knows that in a few hours that letter will be delivered to the door of the addressee. In like manner packages containing that manufacturer's wares, within the limits of certain weights and sizes, may be forwarded over the same route.

How about other commodities whose weight and size require a shipment by freight? I need not tell of the various stages of such a journey, of the congestion at freight terminals; of the delays between the unloading at the outbound door of the terminal and the loading into a car; of its arrival at some transfer point with a further delay. Next of its receipt at the freight warehouse in the consignee's city; the notification of its arrival; of the storage and demurrage charges if not called for by the consignee within a specified time, and finally of its ultimate delivery.

No, you have a mental picture of every step in the process; you are in daily con-

tact with these vexations and know what they mean in loss of time, money and damaged goods. Compare the two systems, the United States Government postal service and the hit and miss of our present freight transportation and ask yourself which is most efficient.

Suppose I visualize for you the future freight transportation. Just let your fancy wander to the point of causing the postman to fill the place of the truckman. Let the mailbag be pictured as a truck and let the postoffice fade into a modern warehouse equipped with the last word in handling equipment. With such a background it is my purpose to fill in the details of the picture.

The development of the motor truck and good roads has been of such recent date that a clear perspective of the relationship of highway transportation to rail and water transportation hitherto has not been granted us. The great importance of the part that highway transportation plays, or can be made to play, in supplying the economic demands of the nation, was forcefully impressed upon us at the time of the threatened general railroad strike. There is not a question but that highway transport could have been so well organized, under government direction, that the vital necessities to human existence could have been indefinitely supplied.

We only need to recall the varied uses that trucks are now called upon to perform to realize that some agency or organization could bring about such a new order of things that the manufacturer or producer could dispatch his commodity to the jobber or ultimate consumer with the same assurance of its ultimate delivery that he now has for his letter or parcel post package.

Our warehouse, under such direction, would then become a highway transport clearing house through which, just like the postoffice, a variety of incoming commodities could be sorted, grouped and packed into empty demountable truck bodies and labeled for a predetermined destination. The truck bodies could then be mounted upon a chassis and sent out on schedule over a known short haul route, or to a railway or water terminal for trans-shipment on longer hauls.

Any loaded truck body could be removed at destination for further handling. A return load body could be picked up, attached to the truck chassis and be delivered to the clearing house. Just keep in mind the postal system and you will visualize the plan.

The system could no doubt be carried still further and the truck bodies, as originally loaded at the clearing house, could be mounted on special railroad flat cars or placed aboard ships and thus be delivered to long haul points. Thus much handling as well as a great deal of time and money could be saved.

The whereabouts of these truck bodies could be recorded in a similar manner to that now employed by railroads to keep track of their rolling stock.

Other problems enter into such a project, such as meeting the fluctuating demand of motor transport, rate making, classification determinations, maintaining schedules and educating the shipper, the consignee and the general public to the advantages of this type of transportation. With a motor transport clearing house properly organized and with an able administrative staff, the details of the practical application of the principles could be worked out.

Let us lay aside this panoramic view and get down to a little more detailed picture of the actual warehouse building, our future motor transport clearing house.

The Warehouse Building.

The selection of a suitable site is the first consideration. Without the proper location we handicap ourselves at the start. An ideal site should have streets on one side and the front, with switch tracks along the other side. An alley or private driveway in the rear and between switch tracks is also desirable. In general the site should be close to the downtown district of the city, near enough to railroad freight terminals to facilitate short hauls, and on ground that is not valuable at a prohibitive figure.

The building itself should be fireproof. A reinforced concrete design, with flat slab floors supported upon round columns, will be found to be the most economical. The width of the building should be a multiple of the width of a bay, a bay being the distance between two rows of columns. The most practical bay width is approximately 18 ft. Therefore, your building could be 72 or 90 ft. in width.

In height it is more economical to erect several stories than a few, because small increases in the width of foundation take care of additional loading and the same roof will cover one or ten stories. Any future additions should be added to the length, rather than to the height.

The walls should be supported on each floor and built in between the outside columns. Hollow tile or brick makes good

wall construction. The hollow tile can be stuccoed on the outside if desired. Since stored goods would usually shut off the light from windows, a line of steel sash lights high and near the ceiling is sufficient.

Platforms should be built along the street side and also the railroad track side. A width of not less than 10 ft. is to be desired. Sometimes a ramp at either end of the platform will be found useful in giving access to the floor or platform elevation from the street or railroad grade line. These platforms should be at car floor or truck floor height above such grade.

Roller steel curtain doors should be provided on the first floor to give ample access to both platforms, for incoming and outgoing shipments.

To facilitate the rapid handling of shipments, either as packages or truck body loads, such things as elevators, moving conveyors, spiral chutes and even cranes and overhead tracks should be carefully considered.

Ample aisle space should be marked out in black paint on all floors, and no goods in storage should be allowed to extend beyond such lines.

Pneumatic tubes for order carrying from the general office to flood stations, as well as dictograph inter-communicating telephones, should be a part of the system, making for quick transaction of business.

The sanitation, heating, lighting and sprinkler systems must be given their consideration and provided. In cold storage warehouses the additional piping system to handle the medium of refrigeration would have to be installed.

We are of the opinion that the first floor should be arranged for the handling of truck bodies. It should be divided into route sections. Local cartage vehicles should deliver to platform, and there the packages should be routed to the sections where truck bodies are being loaded for outbound shipment, or to storage or freight cars, as the case might be. Incoming loaded truck bodies should be run into space allowed to receive them, their contents sorted and routed. When empty they should be immediately moved to outbound section for refilling.

Outbound goods from storage, from freight cars or from local short haul routes are treated in the reverse manner. Loaded truck bodies, as well as freight cars, should clear as soon after being loaded as possible. Ample head room on the first floor and traveling cranes in each bay would facilitate these movements. All terminals should be cleared daily.

Thus highway transportation can be made to relieve railroad and water terminals of the short haul and stabilize what is now a chaotic condition in transportation. It is rapidly coming to the relief of the railways in this perplexing problem. The construction of highways that will stand the punishment of heavy loads will in the next ten years produce tupendous results that should be anticipated by the erection of motor transport clearing houses now. Its value to transportation has been demonstrated in the motor truck terminal operation inaugurated in 1916 at Cincinnati by the Big Four Railway.

Transportation has long awaited the coming of the motor truck, and the motor truck will enter fully into its place as a great transportation agent when the crystallizing influence of motor transport clearing houses will apply it as only such an institution can make the application.

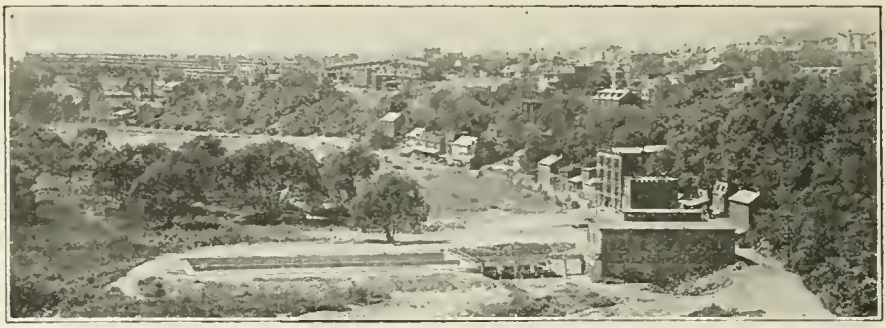
SUCCESSFUL OPERATION OF DIRECT OXIDATION PROCESS OF SEWAGE TREATMENT AT ALLENTOWN, PA.

By Harry F. Bascom, C. E., City Engineer, Allentown, Pa.

The city of Allentown, with a population of approximately 90,000, is located on the Lehigh River, at a point approximately 18 miles above its confluence with the Delaware River, 92 miles west of New York City and 62 miles northwest of Philadelphia. The city is located on a limestone formation, well elevated, consequently well drained, and in the greater part of the city the sub-surface formation, consisting principally of limestone, is of such a loose and open character as to readily accomdate such household wastes as are emptied into the cesspools or "sink holes," as they are called locally.

Until about 1900 no concern was given to the existing conditions, but with the rapid development of the city various difficulties were encountered in disposing of the house sewage by the use of the cesspools, and in many instances connections were made to the existing storm water sewers because of the lack of other facilities.

Commencing in 1902 various investigations were conducted, consulting engineers were engaged and in 1908 plans were prepared and approved and permit issued by



VIEW OF DIRECT OXIDATION PROCESS SEWAGE DISPOSAL PLANT AND SURROUNDINGS, ALLENTOWN, PA.

Plant is in Foreground. Building at Right Contains Mechanical and Electrolytic Apparatus. Left of this are Sludge Beds and Left of These are the Sedimentation Basins, Buildings on Main Street of City at Extreme Right.

the State Department of Health for tanks and sprinkling filters at an estimated cost of $987,000.

This plan did not meet the approval of the electors and was rejected Feb. 16, 1909. In 1914 new plans were prepared, a new site of 462 acres was purchased for $120,000 and a second permit was granted by the State Department of Health, April 18, 1917. Because of its close proximity to the city of Bethlehem, which derives its water supply from the Lehigh River, these plans were also rejected and the tract sold in 1920 for $140,000 to the Lehigh Valley Railroad Co.

Early in February, 1918, under the writer's supervision, the city through its engineering department and with the cooperation of the city laboratories, under the direction of Dr. H. J. Krum, conducted an investigation of the direct oxidation process, which was being demonstrated at Easton, Pa. A few days later the Franklin Institute also conducted a test upon the demonstrating plant.

As a result of the conclusive data ob-

ALLENTOWN SEWAGE DISPOSAL BUILDING VIEWED FROM END OF SEDIMENTATION BASINS.

Tower at left contains lime storage equipment. Basin outlet in foreground center. Residences are shown directly opposite building.

tained from both these investigations, together with the complete absence of nuisance and the small area required, and because of the extreme purity of the effluent necessary to protect the water supply of Bethlehem immediately adjoining, plans and specifications were prepared and approved by the State Department of Health Oct. 1, 1919, for the construction of a sewage treatment works embodying the Direct Oxidation process, "or its equivalent," at an estimated cost of approximately $200,000, which included sedimentation basins and sludge beds.

Description of Plant.

The disposal plant is located on Lawrence St., not more than 700 ft. west of the Eighth St. bridge, covering an area of 0.57 acres, and serves sewage districts Nos. 1, 2 and 14, from which a flow of 1,910,000 gals. per day of sewage uncontaminated with trade wastes, will ultimately be obtained, giving a maximum daily flow of 3,800,000 gals.

Screen Room.

The sewage enters the building from the street mains, then to the intake channel, then through either of two shear gates, over an inclined screen 8x8 ft., with openings of ¼-in. diameter. The solids, larger than the ¼-in. opening, are retained on the screen and are brushed by five revolving brushes, supported on an adjustable frame and driven by a 1 h. p. motor, the speed of the brushes being about 1 ft. per second.

The screened solids are allowed to drain into the grit chambers. They are then incinerated in a 1 ton nominal capacity DeCarie Incinerator during the winter season, but during the summer season the solids are buried. The screen room is the only place where raw sewage can be seen, and the only place in the whole plant where any odor can be detected.

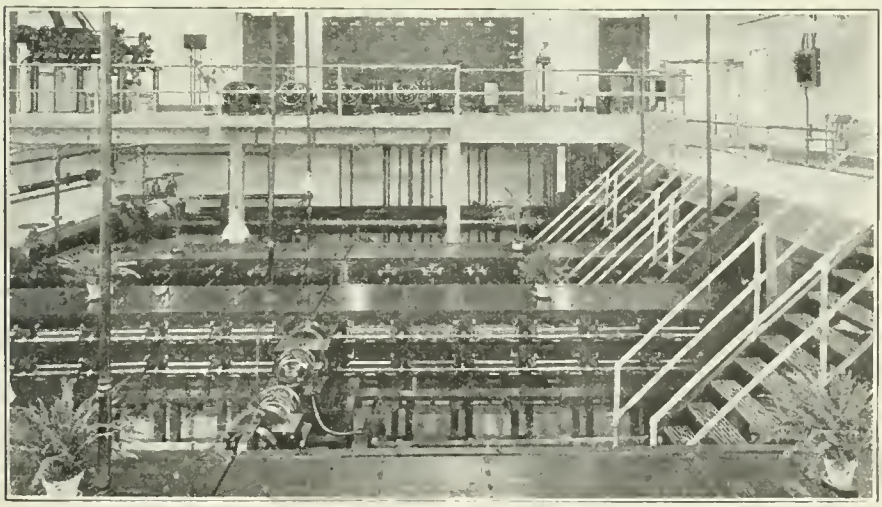
Grit Chambers.

Under the screens are the grit chambers of approximately 170 cu. ft. capacity. From the grit chambers the sewage flows over the overflow wier, through the Venturi meter to the entrance of the electrolyzers.

Lime Tower.

At some point in the line, as far ahead of the entrance to the elctrolyzers as possible and between the electrolyzers and the Venturi meter, pipes are connected to admit of the introduction of the lime which has previously been crushed, pulverized and stored in the lime tower. The lump lime is received in carload lots, transferred by truck to the plant, where it is put through 6-in. grids to the crusher. After passing through the crusher the lime is elevated and stored in the storage tank of 50 tons capacity. Each day when required the crushed lime is pulverized.

The lime feeders are operated by a 1 h. p. motor and the equipment is in duplicate. From the effluent end of the electrolyzers, treated sewage, to be used as a conveying medium for the lime, is pumped, requiring a 2 h. p. motor. This is discharged tangentially to the frustrum of a



VIEW OF INTERIOR OF BUILDING, ALLENTOWN SEWAGE PLANT.

Electrolyzing units on the lower floor. Beyond these, at the right, the venturi meter, with its recording apparatus on the gallery above. On the gallery, at the right, the attendant's desk; in the center, the switchboards, one for each electrolytic unit. At the left, the lime feed apparatus.

cone, where it is mixed with the powdered lime, and both are then discharged into the mixing tank or box. The lime in solution is then run into the pipe leading to the entrance of the electrolyzers, where it receives the specific treatment of the process.

Electrolyzers.

The electrolyzing units, or electrolyzers, three in number, each with a capacity of 1,000,000 gals. per 24 hours, are of the appearance of an enclosed vat 3 ft. wide, 2 ft. 9 ins. high and about 27 ft. 3 ins. long. The top cover in two sections is securely bolted down, resting on rubber gaskets, to make the vat water tight. The cover is made in two sections, to facilitate removal for examination and for cleaning. From the top cover two iron pipes lead upwards several feet to conduct any accumulated gases which may collect in the unit.

The electrolyzer is mounted on vertical wooden legs and over an outlet trench of concrete, which any leakage flows to the sump pit. Underneath the units are located 14 valves for the purpose of cleaning the machine, and this waste sewage also flows through the concrete trench to the sump pit. Sewage enters through a 12-in. pipe, and after a travel of approximately one minute of time through the machine emerges through another 12-in. cast iron pipe at outlet end.

In the electrolyzer, constructed of cypress, are placed 22 sets of electrodes placed 11 sets superimposed above the other 11 sets. Each set of electrodes consists of mild steel plates 3-16-in. thick and 10x16 ins. in dimensions, bolted together at the four corners. Between the mild steel plates and around the bolts are bushings of insulating materials which separates the plates ⅜-in. uniformly. The plates are so connected to and insulated that when joined in the electrolyzing circuit they are alternately positive and negative.

In each space are two paddles 10⅛ ins. in diameter, constructed of non-conducting materials and attached to shafts extending through holes in the plates.

These paddles are entirely insulated from the mild steel plates. The 22 sets of 48 plates each, or 1,056 total, are set across the axis of the machine, the plates being vertical and parallel in rows. The spaces between the sets of plates and the cypress sides of the machine are blocked, thus compelling all of the sewage to flow through the ⅜-in. spaces between the plates. The entire set of paddles are driven by a 3 h. p. motor through a double reduction gear box rigidly attached to the machine, and to two lines of protected bevel gears on the side of the machine attached to the shafts carrying the paddles. The bevel gears operate in oil.

The paddles keep the surface of the plates clear and free of sludge and debris. They also act as mechanical depolarizers. The speed of the paddles is about 20 R. P. M. At the bottom of the electrolyzer units are several valves, through which any accumulation of dirt or grit which may have accumulated is drawn off.

Power Board.

On the slate power board are placed the controlling switches and meters, a rheostat to adjust the current delivered to the electrolyzers, a Watt meter and a pole changer. The polarity of the electrodes is changed periodically to equalize the possible deterioration of the plates and to prevent the building up of the coating of the lime in any of the plates. The normal operation of the machine is at 45 to 55 volts and 50 to 55 amperes, the Watt meter, which registers the power to move the paddles, operates under a normal load of 1,200 to 2,500 watts.

The cells in the electrolyzing unit receive a direct current from a 5 KW. generator, driven by 7½ h. p. motor. The paddle-turning motors are 3 h. p. As each plate had an area of 120.2 sq. ins. per side, and as the 48 plates are electrically connected, so that alternate plates have the same polarity, there are 47 sides, having the same polarity, and each bank contains 5,649.4 sq. ins. of positive and negative electrode area. The total positive and negative electrode area in the apparatus, which contains 22 such banks, is therefore 124,286.6 sq. ins., and the total number of paddles is 2,068.

The efficiency of the apparatus becomes apparent, for it is equivalent to compelling the sewage to flow between electrodes 30 ft. high and 30 ft. long, spaced ⅜-in. apart, in which space 2,068 paddles are revolving, thus bringing every particle of sewage into intimate contact with the electrodes, and thereby utillzing the oxygen and hydrogen while in its nascent or atomic state.

Sump Pumps.

Two low grade gravity lines enter the plant to the sump pit and the main trunk line siphons are frequently drained to the sump pit for cleansing purposes. The two sump pumps are each operated by 7½ h. p. motors. Each pump is capable of raising 600,000 gals. sewage per day from the sump pit to the grit chamber. The pumps

have electric automatic connections and with tell-tale attachment.

To insure operation when the central power plant may be out of service a 30 h. p. Fairbanks-Morse oil engine was installed, which operates a 25 KW. Ac generator. This can be started at a moment's notice. Very few times, however, was it necessary to start this unit during the year.

The entire equipment is housed in a building formerly used as a pumping station, and is 42x72 ft. in inside dimensions.

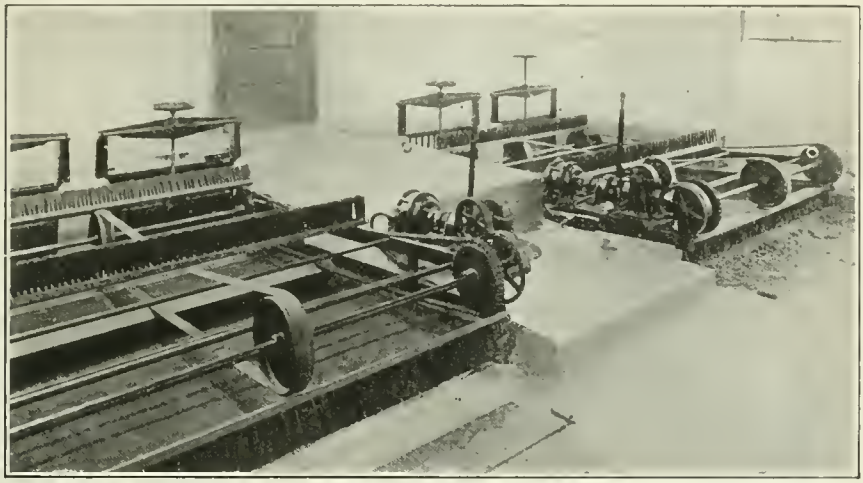
From the observation flume in the main building the sewage passes to and through an elevated reinforced concrete flume 2x3 ft. in section to the distributing flume at the inlet end of the sedimentation basin.

Here the sewage passes through eight port openings 6x6 ins. in section, the openings being regulated by adjustable port regulators to either one of two reinforced concrete sedimentation basins. The dimensions of the basins are 150 ft. long by 31 ft. wide, and of depth at inlet end of 7 ft. and at outlet end of 5 ft. 6 ins. The capacity of each basin is approximately 230,000 gals. The basins are provided with 10-in. valves to draw off the clear liquid at the outlet ends, and at the bottom of the basins are 10-in. valves to draw off the balance of the liquid which passes to the sludge beds. Six-inch valves are also provided at the front ends. The sludge is drawn from each basin by gravity through five under drains and through five 10-in. valves.

The former site of the basin was a swamp, with soft soil bottom, so about 300 reinforced concerte piles 10x12 ins. in dimension were constructed at the site, and driven, on which to place the basin. The basin was thus anchored to prevent destruction by flood in the event that the filling around it be washed away.

Retention period in basins is from 1½ to 2 hours at full capacity of plant.

The sludge beds are 50 ft. long and 61 ft. 6 ins. wide, divided by wooden partitions into six compartments. These beds are underdrained by half sections of vitrified pipe, and above these is coarse stone, fine stone and coarse sand for the filtering medium.



VIEW OF SCREENS AND BRUSHES IN ALLENTOWN SEWAGE PLANT.
Screenings can be seen on the floor in front of the right-hand screen, where they are thrown by the brushes.

During the past year the plant treated 73,000,000 gals. of sewage without the slightest evidence of nuisance or complaint and produced an effluent which was consistently and uniformly stable and of low bacterial count. The sewage is a normal sanitary sewage, and its composition, as well as the average composition of the effluent, is shown in Table 1.

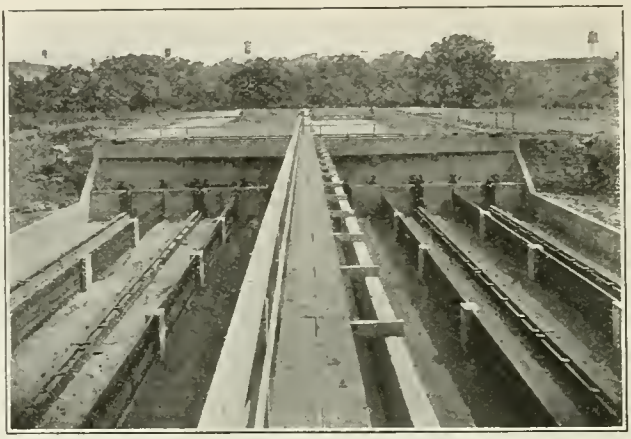
TABLE 1—RESULTS OF DIRECT OXIDATION SEWAGE TREATMENT AT ALLENTOWN, PA.

Suspended Solids	Raw Sewage P. P. M.	Effluent (1 hr. set.) P. P. M.	Pct. Change.
Total	150	69	—54
Volatile	110	46	—58
Oxygen Consumed	17	8.1	—53
Free Ammonia.	21	13	—33
Nitrogen Dissolved	10.4	7.7	—26
Total	24.0	14.6	—39.1
Chlorine	117.0	123.0	+5
Alkalinity (as CaCO3)	287.0	50*	
Bacteria Total 37°C.	2,036,000	12,000	—99.6
B. Coli.	87,000	18	—99.98

*Causticity as CaO.

The sludge, as removed from the sedimentation basin, contains 94 per cent moisture and amounts to 21 cu. yds per million gals. After 4 to 6 days' drying on the sludge beds in normal weather the volume shrinks to 11 cu. yds and the moisture content drops to 71 per cent. Therefore, when dry the sludge will amount to about 3 cu. yds per million gals.

ness of the water supply. Allentown is unfortunate in this respect, in that its water supply is well above the average in hardness, and therefore requires much more lime than many other communities. However, during the past year accurate records of cost have been obtained, and as the flow is continually increasing these data have been computed and checked, and



SEDIMENTATION BASINS AND SLUDGE BEDS, ALLENTOWN SEWAGE PLANT. Walk in Center Rests on Flume Carrying Effluent to Basins. Sludge Beds Are in Foreground.

It is interesting to note that the wet sludge as taken from the sedimentation basin was absolutely fre of colon bacilli, contained 44,000 total bacteria, and when diluted with river water and distilled water had a stability of over 99 per cent, with methylene blue in dilutions ranging from 1 to 25 up to 1 to 1,000.

During the year the sludge has in the main been satisfactorily used for filling around the plant, although in some instances truckers have carted it away and used it on their farms, and they report that it is a very good growth stimulant, soil corrector and improves the mechanical property of the soil.

Regarding the cost of operation, this will vary in different localities due to labor, the cost of power and to the hard-

TABLE II—COST OF OPERATION PER MILLION GALLONS AT FULL CAPACITY OF PLANT (3 MILLION GALLONS).

Power 213 kw. hr. @ 2.8c	5.96
Lime 0.6 ton @ 9.10 per ton (86 percent CaO)	5.46
Operators $135: 2 @ $125; 1 @ $100 per mo.	
Labor, Laborers 2 men @ 40c per hour	7.61
Heat	.08
Light	.17
Misc. supplies and repairs	1.02
	20.30

Giving an operating cost of $20.30 per million gallons.

when the plant operates at full capacity or 3,000,000 gals. per day, our figures show that the cost will be as given in Table II.

During the year several improvements have been made in the lime dosage; a new slacking chamber was installed and the lime added further upstream from the electrolyzers, giving better slaking and mixing, also effecting a saving of approximately 25 per cent in the quantity of lime used.

Lately a new type electrolyzer was installed and tested out, showing a reduction of 50 per cent in the hydraulic head required, as well as an electrical efficiency considerably greater than the older type. This unit has the same effective electrode area as the older ones, but contains only a single row of 10 banks of electrodes, and the agitators reciprocate instead of rotate, being driven from the top instead of the side.

Comparison With Lime Process.

Comment has been frequently made that the Direct Oxidation process is no more efficient than lime alone. In this connection a great number of tests have been made at Allentown both by the City Chemist and by other investigators, and the results are conclusively in favor of the Direct Oxidation process, which gives an effluent that shows a greater reduction in

oxygen demand, oxygen consumed, organic nitrogen and bacteria.

These tests also showed that the effluent produced by lime treatment, even though practically sterile when discharged, will putrefy if mixed with river water, while that from the Direct Oxidation process will stand up indefinitely. When we consider the experience of the British Royal Commission, where litigation arising from nuisance has invariably followed from the installation of lime precipitating plants, and also the findings of the Massachusetts State Board of Health, these comments are untenable, for we have yet to encounter any nuisance at Allentown.

Conclusion.

A very significant feature about the operation of the Direct Oxidation process is that it is mechanical in nature and depends for its success, not upon the delicate adjustment of conditions in an endeavor so far as possible to favor the caprices of bacterial life, but solely upon simple mechanical contrivances whereby lime is fed into the sewage in sufficient quantities to render that sewage always slightly, but definitely caustic, and thereafter to maintain an uninterrupted charge of electric current in the electrolyzers. Outside of these features the process is automatic.

Except in the screen room, where the raw sewage passes over the screens, there is no odor of sewage, stability being obtained in the electrolyzing units without production.

No odors are present outside the building, even from the sludge beds. Fly and mosquito nuisances, such as are always prevalent at all other kinds of sewage disposal works, are unknown at the Allentown plant. A system of this type can be located at any part of the city where favorable delivery of the sewage can be accomplished, and especially where little space is available. Long expensive trunk lines and isolation of the plant is therefore unnecessary, a great saving in dollars to the municipality.

The plant operates irrespective of weather or temperature conditions, purification being accomplished without the aid of living organisms, and its operation is free from all uncertainties of bacterial activity; is not affected by climatic conditions or by changes in sewage, and is positive in action.

The variation in flow of sewage through the electrolyzers up to the capacity of the unit has no effect upon the current required. In other words, any quantity of sewage up to the capacity of the unit requires the same amount of current as the rated flow.

The foregoing paper by Mr. Bascom was presented at the recent annual meeting of the American Society for Municipal Improvements.

HOW GOOD ROADS DEVELOPED POLK COUNTY, FLORIDA

Possibly no county in the United States originally was more handicapped on account of its roads than was Polk County, Florida, seven years ago. To understand Polk County's predicament a brief explanation may not be amiss.

The county lies almost exactly in the center of the Florida peninsula at a point between one and three hundred feet above sea level. In topography it is a section of rolling hills quite sharply accentuated along the "Ridge" and at Lakeland Highlands, but sloping away toward the southwest into vast stretches of flat pine lands. Its soil includes everything from rich black muck to almost pure sand, though in the main it consists of various degrees of sandy loam. The county has about 600 fresh-water lakes of varying sizes, but they are useless for transportation purposes because they are disconnected, though kept fresh by subterranean streams.

Polk County is an agricultural county. It includes within its borders many towns —about 40 in all—the largest of which (Lakeland) has a population of about 12,000 persons. The next largest city (Bartow), the county seat, has a population of 5,000. The total population of the county is about 44,000. The county ranks very high in per capita wealth and in realty values, and stands third in the amount of automobile license fees paid in the state, being surpassed only by two counties where there are large commercial centers.

Ther are definite reasons why an almost strictly agricultural community such as this holds a high place among the counties of Florida and they are to be found principally in its natural resources. In Polk County the finest Florida oranges and grapefruit are produced to the extent of 3,500,000 crates a year. This is two million crates more than any other county in Florida ships, and is about one-third of the state's entire production.

In truck crops and winter fruits, especially strawberries, Polk County stands third. In general farm crop production it heads the list of all counties in the state.

In Polk County, too, one-fifth of the world's phosphate is mined, while from surrounding districts is obtained 42 per cent of the total phosphate production. The phosphate mines in Polk County alone are valued at $19,000,000. Polk County's third great natural resource is its timber, there being vast stretches of pine forests especially.

The county's manufacturing industries are small and, for the most part, are dependent upon its main resources. They include the packing of fruits and vegetables and some canning and preserving. Iron and foundry companies, sawmills and lumber factories are also to be found.

In 1915 Polk County was still a wilderness and was sadly lacking in transportation facilities. Railroads there were, but they were operating only to the principal shipping points and the phosphate mines. There were few of them because development did not warrant more. Ten years ago the town of Lake Wales, for instance, had no railroads. Today it has two.

The problem of growing and marketing the fruits and vegetables was particularly trying because of their perishable character and the peculiar natural difficulties encountered with the sand roads. Older settlers amuse themselves now telling how once it took a day to go from Lakeland to Bartow, a distance of 14 miles, and return. Now it requires but a half hour for the journey each way.

It was in 1915 that Polk County people began to realize that the rest of Florida was forging ahead of them and to grasp the reason why. The main streets of the larger towns contained the only pavements in the county. But the Board of County Commissioners that year took matters into its own hands and laid a couple of demonstration stretches of hard surfaced roads. In 1916 the Board requested and received a bond issue for road building amounting to one and one-half million dollars, the largest single bond issue ever requested for this purpose only in the South. Work progressed rapidly, and by 1919 the original road system of 217 miles, designed to connect every town in the county with every other one, was complete. The county has grown so rapidly since that time that in order to keep the new towns conected with each other by hard-surfaced roads there are now 346 miles of paved roads.

The new roads are of sheet asphalt surface laid on a clay base. To keep the cost down, local products were used almost exclusively in the construction work, the clay being taken from the Bartow clay pits and local soft phosphate rock being often used for the base. Coarse sand and fine Florida limestone for use in the filler happened to be readily available.

The new roads were laid on a clay base about 7 ins. thick. The surface was composed of a 2-in. asphalt sheeting. The roads are very smooth, and since they were laid with proper care as to drainage, are expected to last indefinitely. Since the roads were laid the repair bills have related only to some of the clay shoulders of the 9-ft. roads and, in a few rare instances, to lack of proper drainage in construction.

The new highways have now put the county in the forefront of the fruit and vegetable producing districts. Thousands of acres of new orchards and vegetable gardens, as well as general agricultural lands, have been opened to production, and the marketing of the county's products has not only been rendered more expeditious, but has been greatly reduced in cost. The people of Polk County are now numbered among the most enthusiastic advocates of good roads in the country.

SHOOTING WATER SUPPLY WELLS TO INCREASE THEIR CAPACITY

By W. G. Kirchoffer, Consulting Sanitary and Hydraulic Engineer, 22 N. Carroll Street, Madison, Wis.

The discharge of 20 to 30 lbs. of high explosives in deep wells in rock formations has been found to increase their capacities very materially. The explosives used consisted of 60 per cent dynamite and 60 per cent gelatin nitro glycerine dynamite. The charges generally consisted of 20 to 35 lbs., made up in a cartridge 4 to 6 ins. in diameter by 2 to 3 ft. long and exploded by No. 8 electric exploders.

These cartridges were placed in the wells at depths corresponding to the location of good water-bearing sandstones. Without a knowledge of the formations encountered in a well, shooting would be as likely to spoil a well as it would to improve it.

The first well to be shot was at Burlington, Wis. Here a well had been drilled to a depth of about 1,000 ft. The well yielded 274 gals. per minute, with a lowering of 36 ft.

The Common Council was not satisfied with the capacity of the well. It had been drilled without engineering advice, as one

alderman, who had much to say about the work, advised the other members that "an engineer knows a well only when he sees one."

The Mayor of the city took a hand in matters at this time and called in the writer to advise them what they could do to get more water. To drill deeper to the lower sandstone would have cost them $3,500, which they did not want to spend if it could be avoided. It was, therefore, arranged to have the driller shoot the well at a depth corresponding to the best water-bearing material. Two rather small shots were used, the well cleaned out and another test applied.

During this test 385 gals. per minute were pumped, with a lowering of only 30 ft. The shooting of the well increased the specific capacity of the well from 7.6 gals. per minute per foot of lowering to 12.8 gals. per minute per foot of lowering, or an increase of 68½ per cent.

At the Central State Hospital, Waupun, Wis., an 800 ft. well had been supplying 40 gals. per minute, with a lowering of 100 ft. Four shots were discharged at the location of the best water-bearing rock, and now the new air lift pump raises from 110 to 120 gals. per minute, with a lowering of 12 to 15 ft. The increase in capacity in this case was nearly 1,000 per cent.

Since these two experiences, wells have been shot at the Reformatory, Green Bay; Wisconsin State Prison, Waupun; Southern Wisconsin Home at Union Grove; Viroqua city well, Sauk County Farm, Reedsburg and the city wells at the same place; Cedarburg, city well, and at Clinton Jct., Wis. At all of these places the increased capacity of the well, after shooting, was very marked.

At Clinton Jct., where they had for years been pumping 120 gals. per minute from a 155 ft. level, they now pump 175 to 210 gals. per minute from a 55 ft. level. Three shots raised the water level over 40 ft., besides increasing the capacity.

Some drillers, engineers and air lift pump salesmen claim that shooting does no good and that there is as much danger of losing the water as there is in gaining capacity and head.

At none of these wells was there any capacity lost. At Cedarburg, the only one, the water level after shooting was about 20 ft. lower than before shooting.

A test before shooting showed a capacity of 165 gals. per minute, with a lowering of 44 ft. after shooting a capacity of 220 gals. per minute, with a lowering of only 12 ft., although the water stood higher in the well before shooting, the pumping level at 165 gals. per minute was 56 ft., whereas after shooting the pumping level at 220 gals. per minute was only 44 ft. The specific capacity increased from 3.73 gals. to 18.33 gals., and the energy required to pump a gallon of water decreased 18.6 per cent.

It is very evident in this case that, although the shooting lowered the static level of the water in the well, it did greatly increase the capacity and decrease the cost of pumping. The cause for the loss of head may be due to one or more effects of the shots. This well is cased to a depth of 718 ft. It may be that the jar of the blasts loosened the joint between the casing and the rock and allowed the water to escape into the upper formations, or it may be that the blasts happened to be discharged at levels where the water pressure in the rock was not a maximum, and therefore, with the greater space and surface of rock, allowed the pressure from the strata not disturbed to dissipate itself in the space left by the blasts.

To shoot existing wells at levels where there is non-water-bearing limestones or shales would be hazardous and uncertain.

It is not claimed that shooting would improve cased wells in other formations than water-bearing rock, or that such treatment would do other than destroy screened wells, but it is claimed that the opening up of a large space in water-bearing sand rock increased the capacity for two reasons:

First, it decreased the ground resistance to flow into the well by cutting away the rock adjacent to the relatively small hole and thus reduces resistance to flow.

Second, it makes the opening through which the water has to flow much larger, and thus reduces the resistance to the flow of the water up through the well.

Everyone familiar with wells will admit that a large diameter well will yield more water with the same amount of lowering than a small well will. By shooting we are only making a big well where we need it.

The shooting of these wells under the writer's direction has not only given greater capacity, but has materially reduced the cost of pumping by making it possible to pump a larger quantity of water with a smaller lift.

In a recent article by a representative of one of the big powder companies I noted that he advocated the use of very large cartridges containing 200 lbs. or more of

explosives. From our experience it would appear that several medium-sized charges are preferable to one very large one, as he advocates. Small charges of 1 or 2 lbs. of 40 per cent dynamite are practically useless.

To be successful, the cartridges must be carefully made and loaded with fresh materials and good reliable exploders. They must be properly protected from the water and kept as warm as possible to be really effective. The debris from the shot should be cleaned out to the bottom of the water-bearing formation, but not necessarily to the bottom of the well if drilling was continued into non-water-bearing formations.

RECOMMENDED REGULATION OF MOTOR TRAFFIC AND TRANSPORTATION

(Editor's Note.—The full text of the annual report of the Committee on Traffic and Transportation of the American Society for Municipal Improvements is presented herewith. It contains much matter of interest to public officials charged with the responsibility of drafting regulatory measures for motor traffic and transportation. A. H. Blanchard, Ann Arbor, Mich., is Chairman of the committee and Robert Hoffman of Cleveland, Ohio, and Charles O. Boyd of Beckley, W. Va., are the other members.)

This report is devoted to tentative recommendations which the Committee requested be discussed at the 1922 Convention, and also asked that those interested in efficient traffic regulation and the economic development of highway transport submit criticisms and suggestions relative to the several subjects presented herewith to the Chairman of the Committee prior to July 1, 1923, as it is the intention of the Committee to present recommendations relative to these subjects for final adoption at the 1923 Convention.

Weights and Dimensions of Motor Trucks.

Members of the Society are urged to discuss with the members of their State Legislatures the following dimension and weight regulations for motor trucks with a view to incorporating sane regulations in state laws which would be effective in all cities within a state passing such legislation:

Maximum width of motor truck chassis or body, 96 ins.

Maximum overall height from base of tire to highest point of vehicle or load, 12 ft. 6 ins.

Maximum overall length of vehicle, body and load, 30 ft.

Maximum weight per linear inch of width of solid rubber tires, measured at the base of the rubber, 800 lbs.

Maximum gross weight on one axle, 22,000 lbs.

Maximum gross weight of motor truck and load, 28,000 lbs.

In its 1923 report the Committee intends to present recommendations pertaining to trailers and maximum speeds for motor trucks and trailers operating within cities on different classes of streets for different types of motor trucks and trailers.

Financing of the Reconstruction of Streets

The Committee submits the proposal that the cost of reconstructing pavements and foundations on streets in business districts and main through trunk thoroughfares be financed by general appropriations and not, in cases of such streets, by assessment against abutting property.

License Fees for Motor Vehicles.

The Committee asks criticisms of the following tentative conclusion: That no license fees be charged for the operation or ownership of motor vehicles by any city, but that all such license fees should be collected by the State, and that a certain proportion thereof should be distributed to the cities by the State and be credited to the street maintenance funds.

Franchises for Freight and Passenger Highway Transport Inter-City and Rural Express Companies.

The Committee tentatively recommends that each highway transport company operating an express, freight or passenger service on a definite route and in accordance with a time schedule should be required to obtain a franchise from a State Commision, particularly appointed for this purpose, and should be required to secure the permission of all cities through which it operates to use a definitely prescribed route therein.

Sign Posting for Through Routes in Municipalities.

The Committee suggests that at all corners at which turns are made on through routes in municipalities, direction signs be erected, and at the city limit on each route a large map sign be erected which will show the plan of all through routes in the municipality, giving the names of the streets and the principal adjoining cities to which each route leads.

Safety Car-Stop Zones.

The Committee tentatively recommends that raised car-stop safety zones be universally employed in place of safety zones

designated by limit lines, stanchions or mushrooms. The Committee also recommends that no stopping, ranking or parking be allowed at the curb opposite the safety zones, and for a distance of 10 feet each side of the safety zones.

Railroad Grade Crossings Within Municipalities.

Railroad grade crossings are a constant source of accidents. It is evident that their total elimination is desirable, but unfortunately is not practicable in all cases in the present state of the financing of highway improvements. Much can be done by proper design to reduce traffic hazards in the case of railroads crossing highways at grade. A clear sight of the railroad crossing for 500 ft. on each side materially reduces accidents, and a clear sight of the railroad for 1,000 ft. on each side of the highway is desirable. The width of all roadways crossing railroads should be at least 20 ft. For a distance of 100 ft. on eaeh side of the railroad the grade of the highway should be level or not over 2 ft. rise or fall in 100 ft. The suggestion by some officials to construct humps in the highway to slow down traffic approaching railroad crossings is unreservedly characterized as pernicious.

Proper danger signs should be located at 200 ft. each side of grade crossings in municipalities, and in sections which are poorly lighted at night a large electrically lighted rectangular sign carrying the word "Danger" in red letters should be suspended directly over the center of the street at the grade crossing.

Traffic Regulations for Municipalities.

The Committee recommends the adoption, as for as practicable, of uniform traffic regulations for vehicles and pedestrians in municipalities. It is the intention of the Committee to present a complete set of fundamental regulations in its 1923 Report. In this report there is included only regulations relative to which there may be differences of opinion. It is requested that those interested discuss these regulations with the Chief of Police of the city in which they reside and submit suggestions and criticisms to the Chairman of the Committee prior to July 1, 1923.

Vehicular Traffic Regulations.

No person shall operate an automobile, motor cycle or other motor vehicle on any street or public highway in the business or public highway in the business portion of the municipality at a greater rate of speed than 15 miles an hour, or on any boulevard, drive or parkway at a greater rate of speed than 15 miles an hour, provided such parkway or boulevard drive shall have signs placed at the entrance thereof to indicate such rate of speed, or on any street or public highway elsewhere in the municipality at a greater rate of speed than 20 miles an hour.

Vehicles turning to the left into another street shall pass to the right of and beyond the center of street intersections before turning, and in congested districts, where traffic policemen are stationed at street intersections, an approaching automobile or vehicle shall signal the officer, and shall not pass such officer until receiving proper signal from said officer.

Any person or persons operating or driving any motor vehicle or other vehicle shall, at the intersection of any public street or highway, within the limits of the municipality, keep to the right of the intersection of the center of such street or highway when turning to the right of such intersection.

When vehicles approach an intersection of two or more public streets or highways the vehicle approaching from the right of the driver shall have the right of way.

No vehicle shall turn to proceed in the opposite direction except at street intersections.

A vehicle shall not stop on a cross-walk nor within the intersection of two or more roadways.

No vehicle shall stop on any street except within 1 ft. of the curb, or in such way as to obstruct free passage on the street, provided that this rule shall not apply when a driver of a vehicle is compelled to stop for a standing street car.

Drivers of motor vehicles before starting, turning, stopping, backing or changing their course, hall make sure that such movement can be made with safety, and shall give definite visible signal of such intention.

No vehicle shall stop anywhere in the city with its left side to the curb.

Each bicycle shall be equipped with a suitable horn or bell for giving warning or signal of its approach, and during the hours when lights on the streets are lighted shall be equipped with a suitable head light.

The Chief of Polce may, from time to time, prohibit or regulate the stopping, ranking or parking of motor vehicles or other vehicles in any district where such stopping, ranking or parking will interfere with traffic or the public safety, and no vehicle shall be parked at any time within 15 feet of any fire hydrant.

Not more than two persons shall occupy the front or driver's seat of an automobile, except that a child less than 10 years of age may occupy the front or driver's seat as a third person, and no person, adult or minor, shall be seated in the lap of the driver, nor shall the driver be seated in the lap of a person when the automobile is in motion.

No motor vehicle having an over-all length greater than 20 ft. shall be diagonally or perpendicularly parked at a street curb except when loading or unloading.

Pedestrian Traffic Regulations.

Except where safety zones are established pedestrians shall stand on the sidewalk while waiting for street cars until the street car is within 200 ft. or less from the stopping place, and when alighting from street cars pedestrians shall not stand in the street, but shall proceed immediately to the sidewalk to the right, except where safety zones are provided.

Pedestrians crossing the street in the walk and not from between or back of vehicles in crossing a street without looking in both directions to see approaching vehicles, and shall cross only at right angles with the street.

It shall be the duty of all pedestrians to observe the line of traffic at street intersections and to obey the signal of policemen who are directing the movement of such traffic, and they shall not cross before the signal is given for the traffic to move in the direction toward which the pedestrians are crossing.

Pedestrians shall not cross street intersections diagonally, but they shall cross only one street at a time, using a crosswalk, if designated, or otherwise shall cross at right angles with the street.

Pedestrians crossing the street in the congested district or the business district or crossing any main thoroughfare, shall do so only at street intersections or crosswalks. Pedestrians crossing any street at a point other than a street intersection or cross-walk outside of the congested district or business district or main thoroughfares shall exercise due diligence for their own protection and safety.

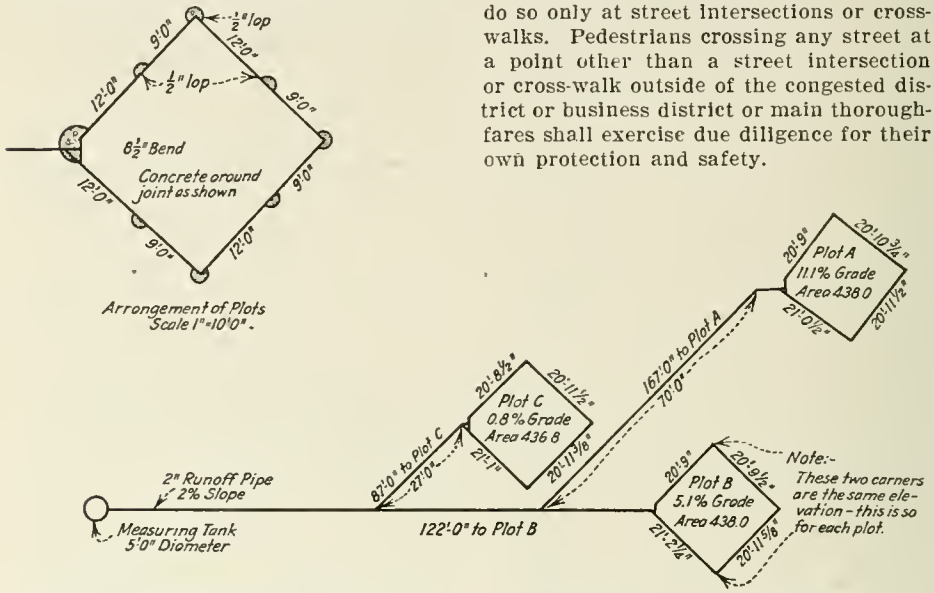


FIG. 1—ARRANGEMENT OF PLOTS ON WHICH SPRINKLING EXPERIMENTS WERE MADE TO DETERMINE RUNOFF AT WASHINGTON UNIVERSITY, ST. LOUIS, MO.

RAINFALL AND RUNOFF STUDIES IN ST. LOUIS; SPRINKLING EXPERIMENTS AT WASHINGTON UNIVERSITY

W. W. Horner, Chief Engineer, Sewers and Paving, City Hall, St. Louis, Mo.

Upon the examination of Volume 8 of the Technical Reports of the Miami Conservancy District the writer became very much interested in the sprinkling experiments described therein. They were carefully studied in an attempt to make use of the results in connection with the rainfall and sewer gauging research which the city of St. Louis has been carrying out.

The experiments, of course, have not been made for use in this connection, and the soil conditions in the Miami Valley were evidently so different from those in the vicinity of St. Louis that the attempt to use these results appeared futile.

This type of experiments, however, contained so many possibilities that it was decided to carry on a similar work in St. Louis under conditions more directly useful in sewer design. The writer secured the interest and co-operation of Prof. J. L. Van Ornum, head of the Civil Engineering Department of Washington University, and an arrangement was finally worked out for the carrying on of this experimental work through co-operation of the university and the engineering department of the city of St. Louis.

The first work was done under Prof. Van Ornum's direction as thesis work for senior students and has been carried on and extended by the engineers of the city during the summer period.

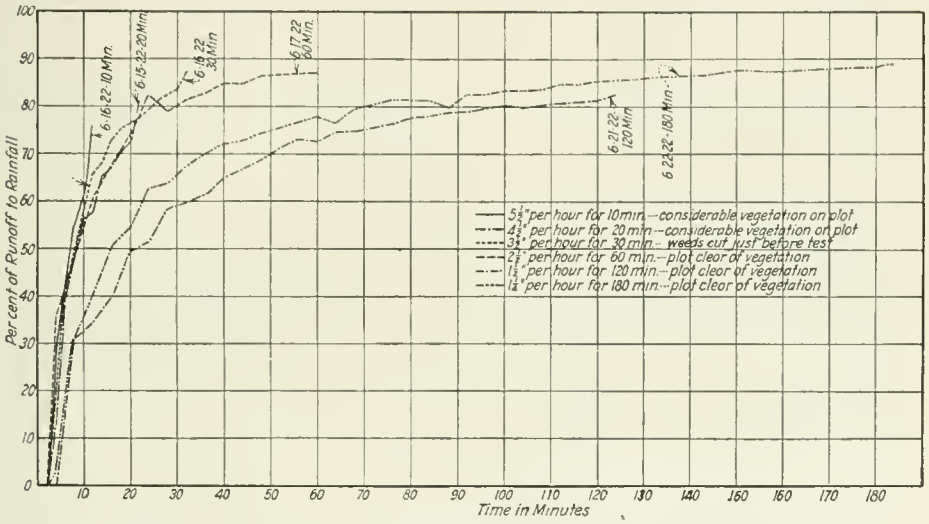

Per cent of Runoff to Rainfall
Time in Minutes
6-16-22 10 Min.
6-15-22 20 Min.
6-16-22 30 Min.
6-17-22 60 Min.
6-21-22 120 Min.
6-23-22 180 Min.
5½" per hour for 10 min.--considerable vegetation on plot
4½" per hour for 20 min.--considerable vegetation on plot
3½" per hour for 30 min.--weeds cut just before test
2½" per hour for 60 min.--plot clear of vegetation
1½" per hour for 120 min.--plot clear of vegetation
¼" per hour for 180 min.--plot clear of vegetation

FIG. 2—RESULTS OF TYPICAL EXPERIMENTS TO DETERMINE RELATION OF RUNOFF TO RAINFALL.

Scope of Experiments

It was decided to carry out the experiments on (a) typical soil conditions as found on the university campus; (b) for both bare soil and sod covering; (c) for three different slopes of surface; (d) for the rates of rainfall commonly considered in municipal sewer design.

Figure I herewith shows the plan of the site. Each bed has an area of 1/100 of an acre and the surface slopes as follows: Plot A, 11%; Plot B, 5%; Plot C, 8/100%. Each plot was carefully separated from the surrounding soil with iron plates driven through the top soil into the solid clay, the strips extending above the ground about 3 ins. At the lower corner of each plot an outlet was furnished into a 2 in. pipe and all drain pipes lead to a measuring tank set below the grade of the plots. In each plot the existing sod and vegetation was skinned off with as little disturbance of the natural soil as possible. The top soil consisted of a clay loam about 10 ins. in depth on the two steeper plots and about 15 ins. on the flat plot. This was underlaid by yellow clay.

Water was supplied through a water meter to three hoses; two of the hoses applied water to the plot through "Cactus" lawn sprinklers, and the third was equipped with a fine spray nozzle and was used in applying water to the corners not reached by the sprinklers. In this way the distribution of water was fairly uniform.

Operation

In the operation of the experiments the sprinklers and nozzle were placed outside of the plot and the valve at the water meter regulated until the discharge reached the desired rate. All outlets were then removed to one of the beds and the experiments started. The water meter was read every two minutes during the heavy rates and every four minutes during the longer runs. Slight adjustments of the regulating valve were made from time to time to keep the rate constant. The discharge or runoff was determined by reading a hook gauge in the measuring tank which had previously been carefully calibrated.

Rates of Application

Rates of application were worked out from the rainfall curve for St. Louis and were taken off for each of the critical

times commonly used in sewer design. These were as follows:

5½ inches per hour for 10 minutes.
4½ inches per hour for 20 minutes.
3½ inches per hour for 30 minutes.
2½ inches per hour for 60 minutes.
1½ inches per hour for 120 minutes.
1¼ inches per hour for 180 minutes.

Soil Samples

Soil samples to determine the moisture content were taken inside of plot at depths of 3 and 12 ins., both before and after the experiments. It soon developed, however, that the absorption was comparatively small and that the saturation never extended to the 3 in. depth. For this reason soil moisture tests were of little value and were merely continued as an index of the soil condition during each run.

Experiments to Date

Three separate runs at each rate of precipitation have now been made on Plots A and B. One complete set and some portions of the second set are available for Plot C. Some additional runs will be made on Plot C after which all three plots will be sodded and will lie over the winter in preparation for the experiments on sod plots next spring.

Results Obtained

The results obtained were recorded in the form shown in Table I. From this form each experiment was plotted on the diagram shown in Fig. 2. On this diagram each line represents an experiment. Each point on the line gives the average percentage of run off up to the time shown on the bottom of the diagram. It will be noted that in each line the last point, or in some instances two points, show a sudden upward trend. These points are taken after application has ceased and represents the maximum rate of runoff which usually occurs from two to four minutes after the end of the rain. As will appear from the record sheets, this results from determining the runoff for a period equal to the period of application and by ignoring the first few minutes in which no runoff occurred, and adding instead the few minutes after the rain during which the runoff still persists. In discussing this later, these higher rates of runoff are referred to as the maximum, while the runoff at the

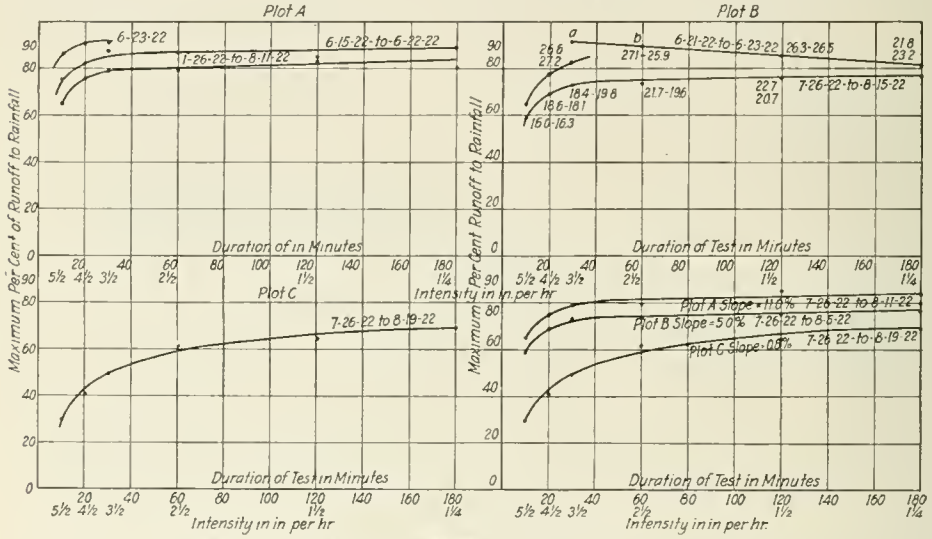


FIG. 3—DIAGRAMS SHOWING MAXIMUM AVERAGE PERCENTAGE OF RUNOFF FOR PERIOD EQUAL TO DURATION OF RAINFALL.

TABLE I

Plot "A" Grade 11.0%
June 15, 1922
Clear. 4½-in. per hour for 20 min. Ar. soil moisture: 3-in. below, 17.5%; 12-in. below, 19.6%.

Time Min.	Hook Gauge Read. ft.	Vol. Tank from Curve cu. ft.	Runoff Dif. of Vol. Tank cu. ft.	Rainfall Meter Read. cu. ft.	Pctge. Runoff to Rainfall
0	11.865	10.3	0.0	0.0	0.0
2	11.865	10.3	0.0	5.5	0.0
4	11.770	12.0	1.7	11.7	14.5
6	11.555	16.3	6.0	15.3	39.2
8	11.352	20.2	9.9	20.7	47.8
10	11.175	23.8	13.5	24.0	56.3
12	10.976	27.3	17.0	29.7	57.5
14	10.750	32.2	21.9	33.5	65.4
16	10.520	36.4	26.1	38.8	67.3
18	10.261	41.9	31.6	44.7	70.7
20	10.000	47.0	36.7	50.4	72.3
22	9.778	51.4	41.1		81.5
24	9.743	51.5	39.5		78.4

end of the rain is called the simultaneous runoff.

While the shape of the lines in Fig. 2 is of considerable interest, the particular points are the end points of each line which represent the maximum average percentage of runoff for a period equal to the duration of the rainfall.

For each of the plots there have been prepared curves for these maximum points. The curves for Plot A are shown in Fig. 3. In this figure each point represents the percentage of runoff resulting from a rain of the duration corresponding and of the intensities corresponding to the duration. It will be noted that for a particular series of experiments covering all durations under a fairly constant condition of soil, points can be connected by a smooth curve. This curve shows that the percentage of runoff would increase with the duration of the rain, the

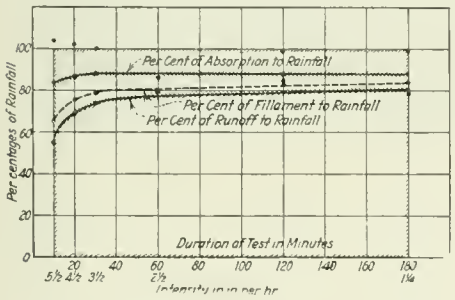

Per Cent of Absorption to Rainfall
Per Cent of Filtrament to Rainfall
Per Cent of Runoff to Rainfall
Percentages of Rainfall
Duration of Test in Minutes
Intensity in in per hr

FIG. 4—RESULTS OF TYPICAL SERIES OF EXPERIMENTS ON ONE BED.

rates of rainfall being the critical rates corresponding to each duration as tabulated above. The change in percentage is quite marked during the first 30 to 60 minutes and is comparatively slight thereafter.

While the extent of this article does not permit of including the necessary data, it also developed that the percentage of runoff was effected quite remarkably by very slight changes in the condition of the surface soil. As an example, the lower curve on Fig. 3 for both Plots A and B represents a run which was taken just after a slight growth of weeds had been removed from the bed. The removal of the weeds disturbed the soil for a depth of ½ to ¼ in. and the difference between the lower and upper curves is largely explained by this surface disturbance.

The effect of absorption by the first 3 ins. of soil made little apparent difference in the results, but continued application of water, for each run, raised the moisture content for a depth of 12 ins., or more, and had quite a marked effect in increasing the percentage of runoff. For instance, on the diagram for Plot B, in Fig. 3, the experiments of the series represented by the lower curve were taken in order beginning with the short rains at intervals of one to four days between runs. As a result of this order the greatest application of water occurred on the last run, that is, on the three hour duration. On the upper curve of this plot the order of runs was reversed, the three hour being taken first, and then the two, one, and one-half hour runs. As a result the soil moisture was increased to a considerable depth and was increased from run to run, producing the remarkable high percentage of runoff shown at points a and b. The small figures opposite each point represent the average soil moisture in percentage of the dry soil weight at depths of 3 and 12 ins. in the bed, the contained moisture at a depth of 3 ins. varied little during these runs.

The effect of surface slope on the percentage of runoff is shown in the lower righthand corner of Fig. 3 where the diagrams for Plot A, B and C for similar soil conditions are reproduced together. While the difference in runoff rates between the 0.8% and 5% grade is very large, the examination of the points of the other diagram in this figure indicate that almost as great a variation may result from a change in the porosity of the surface soil or from the variations in soil moisture. The factors in the last diagram referred too, however, may be used as representing the average percentage of runoff with slopes given from rain falling on the bare soil during the summer months.

Diagrams in Fig. 3 represent results desired for use in sewer design. As a matter of academic interest, however, it was decided to make a further analysis of the data to determine the reasons for some of the variations in percentage of runoff. For this purpose the results were replotted in terms of rainfall volume as compared with runoff volume. The resulting curves are not reproduced here, but the following description of the analysis may be of interest.

It was found that the relation between total rainfall and runoff for each experiment could be represented with a fair degree of accuracy by a straight line. From this line two factors developed. First the intercept of the line on the

rainfall axis gives the amount of water in cubic feet necessary to produce a normal surface film, and second the slope of the line indicates the rate of absorption (and possible evaporation) during the run. The two figures, of the volume of water required to produce a surface film, and the volume lost by absorption, were then divided by the amount of water applied, and the results are taken to represent the percentage of rainfall required for the surface film and the percentage of rainfall lost through absorption. These results were then checked against the percentage of runoff for the same experiment and were found to total out very closely to the required 100 per cent. As an example of this analysis, a typical series of experiments on one bed is reproduced in the diagram in Fig. 4. To the writer, this result is extremely interesting and indicates a possibility of using the data not only for bare soil where absorption is taking place, but for application to paved streets and other impermeable surfaces.

The data is also being analyzed to determine the effect of variation in the intensity of rainfall on the rate of absorption but the results are not sufficient complete for publication. It has become evident, however, that rate of absorption does increase with the increasing intensity of rainfall, but the variation is small and of little importance compared to other factors involved.

It is expected that a similar series of experiments will be carried out on sodded surfaces during the coming year, and from the two series it is hoped that there can be built up a percentage of runoff for average urban districts which can be used in connection with the analysis of the larger scale gaugings which have been taken on the St. Louis sewer system during the past ten years.

FIG. 5—VIEWS SHOWING SPRINKLING OF TEST PLOTS IN DETERMINING RELATION BETWEEN RAINFALL AND RUNOFF AT ST. LOUIS.

SECURING CO-OPERATION BETWEEN ENGINEER AND CONTRACTOR

By W. R. Neel, State Highway Engineer of Georgia, Atlanta, Ga.

In securing co-operation between the engineer and the contractor the first lesson to be learned by the engineer is that he is not only representing the owner, but that he is also representing the contractor. Fairness to these two parties is the engineer's job, said Mr. Neel in addressing a recent meeting of the Southern District of The Asphalt Association at Atlanta. He continued:

First, it must be recognized that the owner or beneficiary should pay the full cost agreed upon for the improvement. The second, that the contractor effecting the improvement should receive a fair compensation for his efforts, insofar as the limitations of the contract will permit. It should be the desire of the engineer so to assist the contractor that after the proper execution of the work a maximum profit can be made. It should be the desire of the contractor so to perform his work that nothing, either in the spirit or the letter of the contract, remains to be done toward securing for the owner a satisfactory job. With both the engineer and the contractor entering into their work with this spirit, true co-operation may be expected.

The laws frequently prevent the very thing for which they are written. They frequently prevent the awarding of the contracts to the best bidder; frequently there are written upon the statute books maximum salaries to be paid engineers, thus preventing the state or county from securing the very best engineering service. Very often you find a resident engineer or a division engineer in charge of a great many construction jobs and clothed with full authority who may or may not be competent, and who frequently is paid less money than the foreman of the construction gang.

Contractors are always on the lookout for good men, and good men are always on the lookout for a means of bettering their positions in life; therefore, it is imperative not only from the interests of the owner, but also from that of the contractor, that adequate salaries be allowed in order to secure and hold competent, experienced engineers. Not only is this true of the engineer, but it is also true of the contractor. A well equipped contractor receiving a fair compensation for his work, with an experienced engineer (and generally this means an engineer receiving a fair salary) in charge of the work, means a smooth running, harmonious job where real co-operation and satisfactory results to the owner may be expected. On the contrary, a poorly equipped contractor who has submitted a bid which will not allow a first-class job with a fair margin of profit, means contentions, and either the slighting of the job or calling on the bondsman, and this always means delay and ultimately a poorly finished job and a dissatisfied public.

Unfortunately all engineers are not to be entrusted with the wide powers generally given the "engineer" by the specifications. There are in every profession what corresponds to the "shyster lawyers" —that is a man who lives by making trouble. Many men employing engineers think that trouble between the contractor and engineer is to be expected, and unless there is some trouble that the engineer is not looking after the job properly or is "in with the contractor." With this before them there are engineers who are unscrupulous enough to make constant trouble for the contractors; the result is loss to all contractors working under them or excessively high prices for work. The only remedy for this, in my opinion, is for reputable contractors to investigate the engineer in charge of work, and in case his reputation is not good to refuse to bid or work in his charge, and to inform the men who employ the engineer the reason for declining to bid. Bonding companies could be required by the contractors to furnish impartial information in regard to an engineer's standing and reputation.

Another cause of trouble is placing an inexperienced engineer in responsible charge of work. Owners will employ a graduate engineer just out of college. The man may be entirely sincere in his efforts, but through lack of knowledge of actual construction conditions he may by over-emphasis of some unimportant point cause a loss or at least unnecessary trouble without bettering the job in the slightest.

A phase of this subject which I consider a real serious one is the insistent bidding of contractors both poorly equipped and incompetent to perform a first-class job, but who can get bond. This class of bidder is a constant menace to the other contractors, as well as to the engineer's reputation. Of course you know how difficult it is for a public official to reject the bid of this class of contractor. In selecting any other than the lowest bid, the public official is immediately accused of partiality and even of graft.

The inspectors and the resident engineer are supposed to be able to enforce the carrying out of the plans and specifications and secure the same result regardless of what class of contractor is doing the work. Yet anyone at all familiar with construction knows how utterly impossible this is. To obtain first-class results experienced, well equipped contractors and competent, experienced engineers, and these co-operating to the best interests of the owner, are absolutely necessary. Now, how can this be accomplished? In my opinion the only practical way is for the engineer to reject all work not coming jam up to the plans and specifications.

If this is plainly understood, the result will be that contractors who are not equipped either with machinery or experience will either be deterred from bidding or very soon driven out of the contracting business. In order to carry out this plan successfully and with every assurance of fairness, specifications must be plainly written and competent engineers and inspectors placed in charge of the work.

CITY PLANNING BROADENS INTO REGIONAL PLANNING

By Nelson P. Lewis, In Charge of Physical Survey, Plan of New York and Its Environs, 130 E. Twenty-second Street, New York, N. Y.

(Editor's note: The following brief report was submitted by Mr. Lewis on behalf of the Committee on City Planning at the recent annual convention of the American Society for Municipal Improvements:)

There has heretofore been a disposition to confine city planning studies to very limited areas. This has been due in part to habit; those responsible for the planning have been accustomed to a restricted, not to say a parochial, attitude toward this subject. Nor was this unnatural, in view of the fact that the first attempts at what

was called "City Planning" in this country were almost wholly confined to a few high spots, such as the creation of civic centers, systems of boulevards, or something more or less spectacular, which would gratify local pride and have some advertising value for the town. In all cases the corporate limits of the city or town were the ultimate boundaries of the imagination of the planning authorities.

There was another reason for this contracted horizon, and that was the strict legal limitation of the jurisdiction of the local authorities within the red lines showing the city limits. There is now a realization that such restrictions are inconsistent with wise planning. The first attempts to extend the powers of local authorities were in the nature of prohibitions expressed as "thou shalt not," or the familiar "verboten." Owners of real estate, for instance, were told that they could not cut up their acreage into streets, blocks and lots and offer it for sale unless the plans for such sub-divisions should first have been approved by some designated authority, while offices of public record were forbidden to accept for filing any plans which did not bear evidence of such approval. At first such regulations applied only to property within the limits of specified cities, but this was soon followed by a long step forward in giving some municipalities similar control over the development of property outside of their boundaries, but contiguous thereto or within a certain number of miles. Progress in this direction was indicated in a report submitted by the writer at the last Convention of the Society. These steps indicated that those responsible for city planning were beginning to think in larger units. If it is desirable that a city should exercise some control over the development of property outside its limits, either within or without those of another jurisdiction, why should not the officials of contiguous or nearby towns sit down together and plan for their future development, or create some machinery by which such joint planning can be done? But there are legal limitations which make it difficult to accomplish anything in this way, and some of the most important planning projects yet undertaken have been the result of volunteer efforts by groups of individuals or quasi-public organizations, generally with, but sometimes, in their initial stages, without the sympathetic interest and co-operation of the municipal authorities.

In various parts of the United States there are groups of cities and towns whose interests are so closely related that it is impossible to plan for one of them without considering the others. Such a group includes Boston and about two score cities and towns within the district tributary to it. Many reports, some of exceptional value, have been made by special committees and commissions, looking to the comprehensive development of this entire district, yet nothing has been accomplished because there has been no machinery for the official adoption and execution of such plans. The Commonwealth of Massachusetts has created certain Metropolitan Boards and Commissions, lately combined in a single Metropolitan District Commission, having jurisdiction over the water supply, the main drainage, and the parks of the entire district, but when it comes to planning for the future development of the towns themselves and their relation to each other, where co-operation or joint action is especially needed, each community is left to go its own way without regard to what its neighbors are doing.

Buffalo has, by vote of its citizens, authorized the City Council to adopt plans for the location and grouping of the public buildings and a group of citizens, under the name of "The Buffalo City Planning Association, Inc.," is going much further than this and is studying Buffalo, not only as a city of well over half a million population, but as a part of the great Niagara Frontier District. This district affords an excellent opportunity for regional planning, involving even international problems, as the plans must necessarily include connections with the Canadian side of the Niagara River.

Early in the present year a Los Angeles County Regional Planning Conference was held, from which it appears that the progressive people of that county realize that, although Los Angeles has, by its various annexations, become the largest city territorially in the world, something more is needed to insure a consistent development of it and of the other cities and towns in this great county with respect to each other.

A persistent but unsuccessful effort to effect, by statute, a consolidation of a number of separate political units into one city was that to combine the towns on that east side of San Francisco Bay in Alameda County. These efforts, however, were, it is understood, confined to the attempt to make a single political unit, and whether, had it been successful, it would have been followed by the creation of machinery to

plan for the development of that unit, as a whole, cannot be stated.

Plan of New York and Environs.

By far the most comprehensive project of the kind which has yet been undertaken is "The Plan of New York and Its Environs," in which it is proposed to include an area of no less than 5,500 square miles, located in three states, with a population of approximately 9,000,000, according to the census of 1920. It will include, in addition to the present City of New York, with its five counties, five additional counties and portions of two others in New York State, eight counties and part of a ninth in New Jersey and a portion of one large county in Connecticut. The special difficulty and the delicacy of the problem is largely due to the fact that there are within the area under consideration nearly 400 different political units —states, counties, cities, towns, villages, boroughs and townships. No one municipal corporation could undertake the preparation of a plan for such an extensive area without arousing jealousies and the suspicion of imperialistic designs upon its smaller neighbors. It follows that a project of this magnitude can be undertaken only by an institution or a group of individuals who have no official connection with any of the political units which would be affected. The Trustees of the Russell Sage Foundation, which was established for the express purpose of "The Improvement of Social and Living Conditions," concluded that one of the most effective ways in which this object could be promoted would be through the preparation of a comprehensive plan for the future development of the district of which New York is the center. A Committee on Plan of New York and Its Environs was appointed under the Chairmanship of Mr. Charles D. Norton, who had been so successful as first Chairman of the Plan of Chicago in starting that great project on its way.

The first public announcement of the purpose of this committee was made at a meeting in New York City on May 10, 1922, at which some notable addresses were made, and Mr. Norton briefly outlined the work which had already been done and what the committee hoped and expected to accomplish. Very brief extracts from several of the addresses made on the occasion will indicate the reaction of the speakers to the proposed plan.

Mr. Herbert Hoover said: "The vision of the region around New York as a well planned location of millions of happy homes and a better working center of millions of men and women grasps the imagination. A definite plan for its accomplishment may be only an ideal. But a people without ideals degenerates—one with practical ideals is already upon the road to attain them."

Miss Lillian D. Wald said: "This seems to me a most important first step towards the most important undertaking that I have heard of for many years. I believe that if it is carried out in logical sequence it will add greatly to the happiness of the people of New York. It links a practical, workable plan with the vision of a city conceived in understanding of the needs of many people, their homes and those matters most closely related to their daily life."

As indicating the necessity of ignoring arbitrary political boundaries in making such a study, Mr. Elihu Root said: "A city, is a growth. It is not the result of political decree or control. You may draw all the lines you please between counties and states, a city is a growth responding to forces not at all political, quite disregarding political lines. It is a growth like that of a crystal responding to forces inherent in the atoms that make it up."

There is probably no precedent for the manner in which the problem is being attacked "with a view," as Mr. Norton stated in his address, "to developing and recording those basic facts and fundamental considerations which are requisite to inform public opinion and to guide the future city planners."

The Physical Survey, which consists largely of an inventory, had already been started. This includes the mapping of existing topographical and other conditions, showing all transportation facilities by rail, water and highway, parks and recreation spaces, public utilities already developed, such as water supply, main drainage, lighting, disposal of wastes, etc., public and quasi-public buildings, density and distribution of population, and whatever local schemes for improvement may be contemplated or in progress. All of this is to be supplemented by an Economic and Industrial Survey, containing an analysis of the fundamental reasons for the existence of this great center of industry and commerce and an inquiry into the economic and occupational activities that create populous districts and those that follow population. There is also a Legal Survey to include the study of existing laws in the several states, or their sub-divisions, which control or affect

a plan for the area, with an analysis of the laws governing zoning, excess condemnation, the stabilization of official city maps, shore rights and land under water; and finally there is also under way a survey of Social and Living Conditions, with studies designed to bring to the attention of those charged with the formulation of the ultimate plan, those factors which have a direct bearing upon human values and social welfare, and make for healthy and satisfactory home surroundings, efficient work and wholesome leisure time.

Serious Physical, Economic and Social Problems.

The great concentration of population about New York may be a source of pride to those who like to think and talk of it as the largest city in the world, but it involves many very serious physical, economic and social problems. In studying the past and probable future population the total area has been divided into three districts: (1), designated as the urban district and consisting of the present city of New York, with Hudson County and Newark in New Jersey, having an area of about 360 square miles; (2), the suburban district, including all of Nassau and Westchester Counties in New York, all of Union County, Essex County (outside of Newark), and portions of Passaic and Bergen Counties in New Jersey, and the eastern part of Fairfield County, Connecticut, having a combined area of about 1,170 square miles; (3), the remainder of the total area, comprising about 3,970 square miles, which is called the rural district.

The increases in population during the census periods since 1850 have been plotted for each of these districts and the curves projected forward to the end of the present century. From them it appears that the urban district, which in 1920 had a population of 6,700,000, will in 1960 contain 13,000,000, and in the year 2000, 20,000,000. The suburban district having 1,360,000 in 1920, will have 5,100,000 in 1960 and 13,000,000 at the end of the century. The rural district had some 940,000 population in 1920, and if its past rate of growth is continued it will have 1,900,000 in 1960 and 4,000,000 at the close of the century. The total population for the entire area at these different times is or is likely to be 9,000,000, 20,000,000 and 37,000,000 respectively. If these forecasts should be verified the average density of population in the urban and suburban districts combined would be equal to the present density in the Department of the Seine, but it makes a very great difference whether such density extends over an area of 1,530 square miles or over a restricted area of 185 square miles, which is that of the Department in which the city of Paris is located.

A recent and rather significant step has been taken in New York, where by an amendment of the State Constitution the Counties of Westchester and Nassau, both contiguous to the present city of New York and included in the area under study by the Committee on Plan of New York and Its Environs, have been given authority to change their form of county government. Commissions have been created to frame charters prescribing the manner in which the county business shall be conducted, and which presumably will provide some machinery for co-operation between the different towns and between them and the unincorporated places or the county itself looking to the future development of the territory as a whole. One of these charter commissions is known to be considering the question of a county zoning plan. Another recent piece of legislation empowered the local authorities, in these same two counties, to adopt zoning plans for the rural district outside of the incorporated places, this being an extension of the zoning idea which would have seemed quite improbable a few years ago.

This brief outline, describing a few of the things that have been attempted and that are being done, will indicate that the city planning horizon is being enlarged, and that when those responsible for such planning are considering the development of street or park system, the location and grouping of public buildings, transportation of passengers and freight by rail and water, or zoning, they are thinking in larger units, are losing sight of artificial political boundaries, or in other words, are trying to do Regional Planning.

PRESENT STATUS OF THE ACTIVATED SLUDGE PROCESS OF SEWAGE TREATMENT

By Langdon Pearse, Sanitary Engineer, The Sanitary District of Chicago, 910 So. Michigan Ave., Chicago, Ill.

Questions are frequently asked by engineers, as well as laymen, about the present status of the Activated Sludge Process of sewage treatment, and whether or not it is likely to cause a complete discard of the other known processes of sewage treatment. The purpose of this article is to outline briefly a general viewpoint of the process, indicating its adaptability and

TABLE 1—TYPICAL ANALYSIS OF SLUDGE.

Source of Sludge.	Per Cent on Dry Basis Nitrogen	Grease	Volatile	Fixed
Imhoff Tank				
Atlanta	1.37	4.8	34.1	65.9
Fitchburg ...	1.71	4.6	35.3	64.7
Batavia	2.93	3.1	47.0	53.0
Chemical Precipitation				
Worcester ...	1.62	1.2	41.8	58.2
Activated Sludge (Municipal Sewage)				
Milwaukee ..	5.82	2.2	67.8	32.2
Houston	4.64	7.1	62.9	37.1

Analyses made in laboratory of The Sanitary District of Chicago. Courtesy of H. P. Ramey, Acting Chief Engineer.

value, and outlining the points which appear to require further investigation. Further, the value of old tried processes, such as the intermittent sand filters or sprinkling filters for many situations, will be emphasized. The need of intensive study of the value of sludges for fertilizer and the encouragement of their use in agriculture will also be mentioned.

Ever since the art of sewage disposal became active in the early nineties the use of air for the purification of sewage has been very attractive, not only to the layman, but to the engineer. In the early days the tests applicable were not always accurate enough to indicate the changes made by simple aeration, but the facts stood out that in the presence of air biological purification went on vigorously though slowly under favorable conditions. Various experiments were made on the aeration of sewage by many observers, which culminated in the process now called the Activated Sludge Process, which holds the center of the field among processes for the direct aeration of sewage. The air used serves a double purpose, first, to provide sufficient oxygen in solution to keep alive the bacterial films and organisms which do the work of purification; and, second, to keep the particles in suspension thoroughly mixed with the liquid. The sludge is retained by settling and used over and over. When the system is in active operation, indications are that amounts of sludge may be removed from the system approximating the dry weight of the suspended matter in the raw sewage entering the system. Of the various sewage treatment processes available the Activated Sludge appears to produce a sludge with the highest nitrogen content and consequently the most likelihood of finding a market.

Observations of the existing activated

TABLE II—ACTIVATED SLUDGE PLANT—COMPARISON OF ESTIMATED COSTS.

City	Estimated Population For Operating Period	Sewage to be handled M. G. D.	Cost of Power per Kw. H. Cts.	Air in Cu. Ft. per Gallon	Annual Cost of Power for Air per Capita	Annual Cost of Power for Air per M. G.	Total Annual Cost per Capita	Total Annual Cost per M. G.	Remarks
Oklahoma City (1)	100,000	10.0	1.75	3.0	$1.85	$50.08	$3.31	$90.80	All Flow
		7.0	1.75	1.5	.75	28.60	1.78	70.00	Without Ind
Chicago, North Side.....	800,000	175.0	.85	1.25	.44	5.44	2.19	27.42	Waste
Urbana and Champaign	35,000		2.93	1.20	.65	24.70	1.70	65.10	
Houston (2)	100.000	7.8			.14	4.80			

(1) Power includes water for cooling blowers.
(2) Actual cost taken from published data combined for two plants.

TABLE III—COST OF SLUDGE PREPARATION—PER TON OF DRY MATERIAL.

	Based on tons per year	Pressing	Drying	Total
Chicago				
Packingtown (a)	28,800	5.72	2.45	8.17
North Side (b)	33,288			15.170
Houston (c)	422	38.00	25.90	63.90
Milwaukee (d)	34,901			11.97

Costs are estimated except for Houston.
Houston expects to materially reduce cost per ton.

(a) Pearse and Richardson. Estimated 1917. Based on coal at $1.75 per ton. No acid included.
Based on 96 tons daily for 300 days a year.
Overhead for superintendence not included.

(b) Eddy, Fuller and Hattton. Estimated 1922. Based on coal at $5.00 per ton. Overhead not included. Based on 365 days a year.

(c) Engineering News Record, 1922, July 27. Vol. 89, p. 132.
Based on raw sludge 422 tons per year.

(d) Approximate estimate, September 9, 1921, from 8th Annual Report Sewerage Commission of the City of Milwaukee, T. Chalkey Hatton, Chief Engineer. Coal at $5.00 per ton.

sludge plants and the various experimental stations indicate that of the various processes available, this seems to have the best promise of operating without nuisance. Trained observers visiting the larger plants in the South report almost unanimously corroborating this statement. The possibility of odors from the sludge handling has not been completely covered as yet by large scale work, but the indications are that this can be done inoffensively, either by lagooning or by filter pressing and drying.

In comparing the work of the Activated Sludge Process with other processes it is natural to take as a yard stick for thorough treatment the tried installation of tanks and sprinkling filters. The experience of the writer with experimental work on various trade wastes indicates that the sprinkling filter still has possibilities, and that it works along with varying loads with far less fluctuation in character of effluent and care in operation than the Activated Sludge Process. It seems to respond to increased load more readily, and to have a power for sustained effort, which indicates that it should still be considered as a valuable means of sewage treatment.

The character of effluent required has a bearing on the choice of process. However, of the various processes available for sewage treatment the activated sludge and tanks and sprinkling filters stand at the top for sizable installations. Intermittent sand filters are serviceable in small works. For sewage treatment generally the removal of suspended matter is usually important, and frequently the additional treatment to stabilize the organic matter, which can best be done by nitrification. High bacterial removals are seldom wanted except in special cases such as the discharge of effluent into the drinking water (Milwaukee). Chloride is very effective for such purposes as a finishing agent.

Two points which appear now to require investigation and further effort are the devices for introducing air, including the amount of air required, and the conditioning of the sludge. I speak of the sludge problem in this fashion because at the present time the difficulty in handling the sludge is not so much a matter of machinery as one of proper conditioning, so that the material will release its water readily. Pretreatment with acid and with heat has been serviceable in many cases. Various types of filter presses are available which will produce a cake with proper sludge. Considerable interest has been aroused by the ease with which thin cakes are formed on vacuum filters, such as the Oliver or American filters. Continued operating data on a working scale are required to settle the claims of various apparatus, and determine the relative value of each under all conditions.

Economies in the use of air may be produced as a result of the various experiments under way. Interest in mechanical aeration has revived in many types, but no very definite tests are available. The placing of the filtros plates eccentrically on the bottom is also being tried, with provision for vigorous overturning of the liquid (Chicago, Indianapolis). The limits of effectiveness are being studied, as it is essential to keep all the sludge in motion.

The problem which confronts many city officials in making a choice of processes is the annual cost thereof, including not only the cost of operation, but the interest and depreciation. This feature has an important bearing, where it is relatively easy to raise the larger sums of money by bond issues, and where the annual income by taxation or otherwise is limited upon the smaller installations; for instance, towns of 50,000 and under. Where the plant is

TABLE C—COST OF POWER.

Available for Activated Sludge Projects. City	Cents per k.w.h	Project or source.
Chicago	0.85	North Side, 1922
Chicago	0.7	Packingtown, 1917
Milwaukee	0.7	Stated in early report
Houston	0.6	Recent article
Indianapolis	1.0	Estimated cost of producing power
Sherman	1.75	

TABLE A.

Process.	First Cost.	Total Annual Cost.	Estimated Cost per Million Gal.
Tanks and Sprinkling Filters	$400,000	$46,800.00	$51.28
Activated Sludge	300,000	66,500.00	72.86

TABLE B.

Process.	First Cost.	Total Annual Cost.	Estimated Cost per Million Gal.
Tanks and Sprinkling Filters	$16,266,000	$1,766,000	$27.84
Activated Sludge with Drying	14,503,000	2,210,000	34.60
Activated Sludge with Lagooning	13,203,000	1,751,000	27.42

TABLE IV—SUMMARY OF ACTIVATED SLUDGE TESTS APRIL, 1920.

	Chicago Racine Ave.	Milwaukee	Cleveland	Brooklyn	Houston Act. Plant	Worcester	Urbana	New Haven	Pasadena	Baltimore	Brockton
Gals. per Cap. Daily	Industrial	322	160	102.5				180	50	100	84
Preliminary Treatment	20 or 30 Mesh	3/32 and ⅛	6		Bar Screen	Bar Screen ½	Vert. Bars ¾ Grit Chamber		Bar 0.5	1	40 mesh
Aeration Tanks—											
Period Hrs.	7 to 13	4-6	1-3	0.5-72	2-4	3.8-6.5	4-6	2.7	4	24	2.8-4.6
Depth Ft.	11	15	15.08		9.5	10					16-91
Per Cent Sludge	19-58		15-25	10-30		17-35	12-24	8-17.5	8-16	30	1.3-6.5
Air Cu. Ft. Gal.	3.27-6.52	1.25-1.5	0.75‡	0.1-30		2-5	1.6-3.1	1.3	1	0.67	2.2-5.3
Air Cu. Ft. per Sq. Ft. Min.	0.24-0.59		0.25			1.66-3.24	0.16-0.33		0.2		16
Filtros Perct. Tank Area	16	25-16	20		b23.3 c24.5	5.2-4	25	24	12		None
Reaeration Tanks		None	Sludge Reaeration Only in certain runs			o and	None	None		None	
Period Hrs.	Aeration 4.9-7.1 Reaeration 3.3-4.4			0.5-3		2.8-65			2-4		
Percent. Flow	65-92			5-30		17-35			40-50		
Settling Tanks											
Type	Hopper 1.8 to 1 Hor.	Sq. Top Cir. Bott. Dorr Thick.	Horizontal Hopper 1.1 no good	1. Imhoff 2. Hopper 1.1 no good 1.2 good 1.3 better	Hopper	Hopper 1.5-1 no good	Hopper	Hopper	Hopper	Sed. compt. of Imhoff Tank	Hopper 1.1 slope
Depth Settling Ft.		15	27	3-2 5-7	21.5	9.6	11	12	13		6′-10″ to base of cone
Depth Sludge Ft.		1.5-13	8-12	10-40 pct.		9					
Period Hrs.	1.1-2.2		0.5-1	0.25-12	1.8-3-6	c1.6-2.9	0.4-0.6	1.0	0.75	25	0.67-1.33
Gal. Sq. Ft. 24 Hrs.	575	1600-1800				607-1039	1000-2700		800		
Sludge—											
Lb. per Mil. Gals.	1916-2420 1917-1924	2000	1300	Variable			*740-1150		1390		
Percent. Moisture	99	95-99	97-99	98.5-99.5			*10		98-99.3		99
Percent. Sludge to Susp. Mat.	84-95								1-1.7		
Percent. N (Dry)	4.4		3.21				*4.5-5.7	3.2	5.8		
Effluent-Stability	Summer 75-95 Winter 20-30	120 hr.†	Clarification	†0-100			50-100				

a Could be shorter.
b Aeration tank.
c Reaeration tank.
* From exp. of 1915.
† The average result with 4 hr. aerating and 1 cu. ft. air per gal. of average sewage was about 85% stability; nitrites 0.6 p.p.m; nitrates 2.5 p.p.m. Moisture of sludge, 99%.

TABLE V—COMPARATIVE ANALYSES OF CRUDE SEWAGE—PARTS PER MILLION.

Constituent	Chicago 39th St. 1909-1912	Chicago Racine Ave. Day Night	Milwaukee 1917	Cleveland 1913	Brooklyn 26th Ward	Houston 1915 T.	Houston 1915 S.	Worcester 1917-1918	Urbana	New Haven East St.	Pasadena 1917	Baltimore	Crockton Screened
Nitrogen as—													
Org. N.....	7.8	‡7.9	*40	8.5	27	5.5		8	°11.5-32	10.0	20		
Alb. Amm.			16.8						§2.4 7.2				8.6
Free Amm. ...	9.1	‡22	17.8	12	32	6.3	15	19	13-16	4.4	82	24	30.4
NO_2	0.10	‡0.49	0.10		0.26	Tr.	0		2.4 5.5				0.17
NO_3	0.33	‡3.04	0.04		0.00	Tr.	0.1		2.4 5.5	1.6	0.27		0.16
Oxy. Cons.	43	181	146	50	61	139	88	124.5	46-58	37	165	113	111.7
Chlorine	40	‡1100	238	254	35-50			102	§30-100	695	90	170	139
Alkalinity	212	‡291	256	137	200†				§350-460	53			
Total Solids.			1215		600-800			837	§700-1000		717		629
Susp. Mat.—										97			
Total	144	408-193	244	252	136-200	253-192		244	90-130		282	256	162
					Avg. 168					63			
Volatile	90	334		126	108-150			173					
					Avg. 129								
Fixed	54	74		130	39†			71					
										34			
Fats		148-72		20				51.9		10-15			
Iron										0.6-12.0			
Bio. Oxy. Dem..		960			223	103-176			220-260				

Exclusive of Sundays which are weaker than night. * Includes free ammonia. ° Analysis of 1915. § Analysis of 1906.

located in the outskirts beyond the built-up sections, the tank and sprinkling filter installation are likely to be the more expensive in first cost, but cheaper in annual cost. In a recent report for a group of towns aggregating 45,000 population the comparative costs in Table A were estimated by Pearse, Greeley and Hansen, the power being offered by the power company at 2.93 cents per k. w. hr.

In such installations the protection of large surrounding areas may not be so necessary as in the large installations which frequently have to be built right upon the outskirts of the city. As an interesting comparison, figures in Table B may be cited from a recent report made by the engineering commission composed of Messrs. Eddy, Fuller and Hatton on the North Side Treatment Works for the Sanitary District of Chicago, to handle the sewage of 800,000 people.

These costs include pumping station cost, but not any plant for generation of power, power being figured on a bought basis. Further, a belt of land half a mile wide aronnd the site is included in the sprinkling filter project.

The column, "total annual cost," gives the annual cost, including interest, depreciation, maintenance and operation.

The preparation of the sludge in the small plant does not seem at present attractive unless in exceptional cases where local agricultural demands make a market; otherwise the cost of preparation may exceed, under present conditions, the value which can be obtained for the finished produce, screened, dried and bagged for market.

Particularly on large installations the offset to the annual cost is that the investment in intercepting sewers would materially be reduced by locating the plant at or near the source of the sewage. This is particularly valuable in relation to certain industrial problems which occasionally arise.

The cost of power is a very important item, inasmuch as in round figures around 12 h. p. are required per 1,000 population, with 200 gals. per 24 hours flow per capita. For the large plants low power costs are available, as for instance at Milwaukee, Chicago and Houston. In the smaller cities, where estimates have been made, power runs from 2 to 3c per K. W. hr., making a much higher annual charge. Until the power required is reduced this is an important item. (Table C.)

In the comparison of estimates, operating costs should be carefully scanned. In

a small city like Sherman, Texas, one man runs the plant. However, he lives nearby, and further has no sludge disposal to look after. On the other hand, where sludge disposal is contemplated, the overhead charges may be approximately the same in small plants for a range of tonnage produced. The cost of sludge preparation in the smaller plants may run high on account of the necessary overhead and small output. Costs will probably vary considerably with working conditions, and the market prices of labor and fuel, as shown by Table 3.

The value of the sludge is a question as yet which can only be settled through actual test over a series of years by agricultural experts skilled in comparing fertilizers. Apparently the sludge has enough nitrogen ordinarily to be of some value. At present freight rates the values contained apparently will not warrant long hauls. Under recent financial aod agricultural conditions low grade fertilizers have been a drug on the market. Such conditions, however, should prove temporary. In the meantime steps have been taken to interest various agricultural experiment stations in intensive study of the material. As a financial venture at the present time, the preparation of the sludge with a 5 per cent nitrogen content may cost more than the possible sale price today in many localities. Hence the recommendation of lagooning by Messrs. Eddy, Fuller and Hatton for the North Side project of the Sanitary District of Chicago as an immediate outlet for the sludge pending further developments.

A compilation of data on the various activated sludge plants in the United States may be of interest, though not entirely complete, as the small plants like San Marcos and Sherman, Texas, are omitted, as well as the industrial waste work of the Sanitary District on tanneries and corn products. (Tables 4 and 5). Some improvement is reported by Milwaukee over the operating data given in Table 4.

To sum up, the activated sludge process is a demonstrated fact, effecting a high grade of purification and producing a sludge higher in nitrogen than the average sedimentation sludge. In small cities of less than 50,000, where power costs are high, the annual cost may prove high. In larger cities and for special problems in industrial wastes, the annual cost may be considerably lower. Estimates and studies for particular localities alone will lead to a decision. With proper care and adequate design either the activated sludge process or the sprinkling filter should produce good results if not overloaded. The choice will depend on a thorough study of local conditions, not only of engineering, but of finance.

DESIGNING WATER DISTRIBUTION SYSTEM

By Eugene Schaub, C. E., Mem. Am. Soc. C. E., Logan, Utah.

While the author realizes the fact that the efficient design and arrangement of a water pipe distribution system requires much judgment and experience, besides knowledge of the fundamental principles of hydraulics pertaining to the flow of water in pipes, there are, at the same time, many methods in use to acquire a desired end.

One method is by means of visionary pressure contours when the entire system is assumed to be in action, or if the entire system is composed of several component parts, each part being considered in connection with the other parts under a synchronous action.

In addition to the effective arrangement and design of a system it is high time that valve and fire hydrant placing be standardized; also that a standard size nipple and nipple thread be adopted everywhere in the United States. The author has it from an authentic source that we have a great number of different kinds of fire hose nipples and hose nipple threads. This sort of a thing must be discouraged in the installation of fire hydrants if we expect to help one another effectively in the various communities in case of a serious fire. What I mean by this, is: One fire fighting crew with its equipment in one town should be able to make his equipment fit for help in the next or neighboring town. Many communities, under different charters, are built close together, and the author knows of some cases having 6½ threads and the adjacent village an 8-thread, a deplorable situation.

The premises upon which to conclude a design and arrangement are:

(1) Population density and probable maximum use.

(2) Contour map of the section or sections under consideration.

(3) Minimum pressures under a maximum demand.

Having the ground contour lines on the map in one color, we can place on this same map a set of contours in a different color representing the flow pressure plane

below the hydrostatic plane. The difference between the ground contour and the flow pressure plan contours is the effective pressure head. The difference between the flow pressure plane and the hydrostatic plane is the drop in pressure at any one point in question.

Starting at the lowest levels one must proportion his size of pipes in such a manner that his pressure contour planes will be elevated, as near as possible, a constant distance from the ground contour plane. The hydrostatic plane, of course, is one whose equation has a definite form, and whose position is well defined, as is the ground contour plane. The hydraulic plane, on the other hand, is one in which more or less uncertainty is always present. However, by careful study and conservative judgment in the design or selection of the various dlameters, one will arrive at a plane whose plotted position will be a great aid in checking up on the probable future action of the system. This method is the graphlcs of the probahle water action in a system of pipes under the assumed conditions. It is always better practice to design for a hydraulic plane higher than at first desired. Many have laid out a system without due regard to this hydraulic plane, and the result is that we have many systems in which our pressure is far below the desired minlmum when the system is in action.

Proceeding upward from the lower levels with the hydraulic plane, we will at some point very nearly coincide with the hydrostatic plane, and would coincide lf our mains from the source of supply were amply large. However, the segment between this limit and the hydrostatic plane is one of economics with respect to cost in pipe sizes. This approaching and limiting drop in pressure head near the source of supply must always be kept down to a small margin.

The fundamental expression for loss in head equals $K\left(\frac{v^2 l}{2gd}\right)$, the value of K, of course, depends upon the nature of the pipe interior. These values have been determined in a general way, and can be found by referring to the various authorities on this coefficient. This expression may be simplified for use in any one particular type of installation.

The author's experience in the installation of a system from the design is another important part of the work. The value of close inspection during the process of caulking the joints is one that cannot be over-estimated. There are a great many sloppy caulkers posing as efficient workers, and the best thing to do when one shows up to dispense with him.

The author has had a great amount of experience in designing water works systems. In the placing of valves and fire hydrants the following system has been adopted and put into effect whenever possible: Two valves at each street intersection, always placed on the property lines, one on the north and one on the west side. This, of course, is with respect to a rectangular layout. In an irregular layout of city property an arrangement of symmetry can be adopted by facing a definite objective and placing the first valve forward and thence turning counter-clock wise to the next street for the second valve. By adopting a definite system the work of the water department will be much simplified.

Next in order, and of equal importance, is placing the fire hydrant at a point where it is easily accessible in case of fire and where lt has the most exposure to the sun. The author has adopted the southeast corner of each hlock as a standard placing, heing set back 3 ft. from the street line. Placing the fire hydrants in a systematlc manner will always enable the fire department to render most and quickest service. They know before hand just where a hydrant can be used.

The author has had considerable experience with respect to electrolytic actlon on water pipes due to stray direct current, and cautions that every known method be adopted to reduce this actlon to a minimum.

It is also extremely important that the water superintendent makes a periodical report, on a printed form supplied for this purpose, of the detailed inspection of every fire hydrant and valve. Each fire hydrant should be given a thorough test once every month and so reported. All inspection reports should be kept on file.

ASPHALTIC CONCRETE BASE USED IN REPAIRING PORTION OF WASHINGTON BOULEVARD, CHICAGO

By John B. Hittell, Mem. W. S. E., District Engineer, The Asphalt Association, 729 Hearst Bldg., Chicago, Ill.

Washington Boulevard, Chicago, from Halsted St. to Ogden Ave., under the jurisdiction of the West Chicago Park Commissioners, is being repaved with a standard 2-in. sheet asphalt wearing surface

upon an asphaltic concrete (black base) foundation. The roadway width is 48 ft. and the length 4,630 ft.; the sq. yardage approximates 26,000. The Commonwealth Improvement Company of Chicago, being the lowest bidder, secured the contract.

While nominally a boulevard, the layout of the street with its half or staggered intersections is such that heavy traffic will be permitted in going between intersecting outlets. There are 13 streets leading onto the boulevard at intervals of about 330 ft. from which unrestricted traffic will cross over or use the street to the next nearest intersection. Halsted St., the eastern terminus of the improvement, is only a mile and a quarter from Lake Michigan, and lies at the door of the West Side manufacturing district. Within the limits of the improvement the street has long since passed the state of a residential boulevard, and is fronted by many manufacturing or heavy trucking concerns. Among these may be mentioned the National Biscuit Co., United States Postoffice garage and the Chicago Machinery Exchange. These conditions, the general disturbance of the macadam foundation prior to the present paving operations, and a small increase in elevation of the new surface were among the reasons prompting the Commissioners in selecting a resilient instead of a rigid base for the wearing surface.

Mr. Wm. G. Barclay, Superintendent, West Chicago Park Commissioners, in speaking of the improvement, said:

"This part of Washington Boulevard was paved with asphalt in 1893 and some of the intersections were repaved in 1906.

"The areas of the numerous intersections, as well as those of parts of the roadway from which heavy or truck traffic cannot be barred owing to the fact that many of the interesecting streets do not continue in line across the roadway, summed up, are probably 50 per cent of the entire area, so that in effect the pavement will be subjected to a traffic similar to that on any business street nearby.

VIEWS SHOWING CONSTRUCTION OF ASPHALTIC CONCRETE BASE FOR SHEET ASPHALT PAVEMENT ON WASHINGTON BLVD., CHICAGO.
Left: Macadam Foundation and First Layer of Black Base Partially Rolled.
Right: Raking Second or Final Layer of Black Base.

"The disturbance of the old macadam foundation was very general. One corporation made openings every 25 ft. along the street, and much rehabilitation work on underground services was necessary, due to the period of 29 years between the placing of the pavement in 1893 and this.

"The Commissioners, knowing that additional materials were needed to provide a proper foundation, carefully considered the merits of Portland cement concrete

and black base. Their investigations of the bituminous type of foundation in several cities and the opinion of the engineers experienced in pavement construction convinced them that the black base would be the better of the two. Being resilient, it absorbed some of the shock of impact of traffic, thus protecting both the wearing surface and the macadam base; that full contact would be had with the base and perfect bond with the wearing surface; the binder course could be eliminated, and that the work would progress more rapidly, as no time would be lost as in waiting for an hydraulic concrete base to cure, an important consideration at this time (Fall) of the year and the demands of traffic."

The placing of the black base involved no methods of construction differing from those commonly employed in laying binder. Where the depth of it was more than 3½ ins. the base was laid in two courses, as shown in the illustration.

Standard Mexican asphalt, produced by the Standard Oil Co. of New Jersey, is used in the asphaltic concrete base and wearing course, typical analyses of which are as follows:

Base.		Wearing Course.	
Bitumen	4.9	Bitumen	10.0%
Pass. 200 mesh	2.0	Pass. 200 mesh	12.3
Pass. 80 mesh	9.5	Pass. 80 mesh	29.9
Pass. 40 mesh	5.6	Pass. 40 mesh	37.7
Pass. 10 mesh	3.1	Pass. 10 mesh	10.1
Pass. 4 mesh	10.2		
Pass. ½ mesh	24.6	Pen AC	41
Pass. ¾ mesh	28.4		
Pass. 1 mesh	11.7		

For the West Chicago Park Commissioners Mr. William G. Barclay, Superintendent, has general charge, while William G. Keith, engineer; Thomas Newton, field engineer, and William A. Basse, inspector, are responsible for details of office and construction work. Messrs. Alexander Todd and Walter Leininger, constituting the Commonwealth Improvement Co., are giving particular attention to the construction, with William G. Foley as foreman in charge.

Walter H. Flood & Co. and the Chicago Paving Laboratory are acting, respectively, as chemical engineers for the contractor and commissioners.

TROUBLES EXPERIENCED IN MODERN METHODS OF GARBAGE DISPOSAL

By Samuel A. Greeley, of Pearse, Greeley & Hansen, Consulting Engineers, 39 W. Adams St., Chicago, Ill.

The practice of refuse collection and disposal in American municipalities has been characterized by some well informed observers as a mess of mistakes. They see a wide variety of disposal methods in use, and in some cities apparently abrupt changes from one method to another, sometimes involving the abandonment of seemingly useful and expensive going plants. They see large and costly disposal works built and operated for a few years and then abandoned to gradual disintegration. The city engineer of Gary writes that "our incinerators have been out of service for seven years and would have to be rebuilt to make them serviceable." Los Angeles, after seven years' operation of a garbage reduction plant, has abandoned it (at least for the present) in favor of hog feeding. Baltimore, after a few years of hog feeding for garbage disposal, has turned again to reduction; and Buffalo, with hog feeding established for a while, has recently taken bids for incineration. The large reduction plant at New York and a group of incinerators at Seattle have all been abandoned in favor of dumping at sea.

The critical observer further notes many different disposal methods in use in different cities, with reported satisfactory results. Thus at Minneapolis the garbage is burned with some rubbish, while in St. Paul it is taken to several farms for feeding to hogs. In the metropolitan district of New York, the Borough of Queens burns the garbage and rubbish; the Borough of Richmond burns mixed refuse; Manhattan and the Bronx dump the garbage at sea; Newark feeds the garbage to hogs. A short distance up the State, Schenectady, Rochester and Syracuse have reduction plants. These are situations which merit interest and consideration.

Fundamental Considerations.

Having these observations in mind, it becomes increasingly important to emphasize the fundamental considerations largely controlling the problem of refuse collection and disposal. If service to householders and proprietors be held of first importance, with economy of operation following closely, then the observer's perspective shows the disposal of refuse as of somewhat less importance than the collection service. If two somewhat similar cities (as for instance, St. Paul and Minneapolis) have equally good collection service, it is quite possible that general satisfaction among householders can be secured with different methods of disposal. If the different disposal methods are well administered, the difference between them is largely one of annual cost.

Therefore, at the risk of repetition, let

me state the four parts or phases of the refuse problem as follows:

a. The house treatment.
b. The collection.
c. The transportation or haul.
d. The final disposal.

Of these phases of the problem, the collection and transportation are the costly part of the work (on an annual basis). As the collection also orients or establishes the standard of service to houses, it merits first consideration in the development of a general plan. If the development of general plans for refuse disposal, or the readjustment of existing methods were oriented squarely to the relative importance of these various phases of the problem, the shifts and failures, which our informed observer finds, would not so frequently occur.

Let us note, however, that recent years have marked a promising realization of the importance of collection work and the related problem of haul. Much has been acomplished through motorization as at Los Angeles, Montclair, Minneapolis and elsewhere, although final economies are not yet established. Further progress toward economy has resulted through the use of the tracter-trailer and the establishment of transfer stations which permit the decrease of the expensive collection haul with an increase in cheaper quantity haul.

Importance of Haul.

Thus a review of refuse disposal practice in the light of some of the projects recently developed, particularly in the larger cities, reveals, among other things, a growing realization of the importance of haul. By haul is meant the travel of the loaded collection unit from the collection district in which the refuse is produced to the place of disposal. This item in fact links up the various phases of the refuse disposal problem from the house treatment to the final disposal. In plain terms the gradual exhaustion of dumping grounds and disposal sites and the increasing cost of haul have curtailed the collection service to such an extent that public opinion has come to the front for improved service. This is a situation which, if rightly turned, can greatly assist the development of improved service through acquirement of sites, overhauling of collection equipment and construction of disposal works. With increasing costs of haul old appropriations cannot continue the collection service desired, so that betterments and economies are requisite. If nearby dumps become filled, how can the old budget carry double or triple the haul without curtailing the service? This can only be accomplished by more economical methods, or by increased budgets, and often both are needed. Thus the haul becomes involved with the dump and the disposal plant, for oftentimes the method of disposal will increase or decrease the useful life of dumps.

Improved Operation of Dumps.

The dump, in my judgment, is likely to be a factor in the disposal of refuse in nearly all cities for many years to come. It should, therefore, be given much attention in operation and use. Of first importance is the sanitary maintenance. Efforts to secure a rat-proof dump are becoming more prevalent, so that garbage is taken less frequently to dumps. The 1920 New York Commission reached the general conclusion that not only garbage, but rubbish and street sweepings as well, should be kept off of dumps. This consideration was an element in the decision which has led Philadelphia to take bids recently on a large rubbish and garbage incinerator.

As related to the problem of increasing hauls and the contingent stretching of the budget, the life of the dump becomes important. This is a local problem involving the availability and extent of dumping areas and of other methods of disposal. Thus if mixed refuse (garbage, ashes and rubbish) is burned, the bulk to be dumped is reduced by 60 per cent or more. If the garbage is fed to hogs, only about one-third need be otherwise disposed of. The matter of available dumping grounds has become acute in many of the larger cities, including London and Chicago, as commented on below.

A Typical Condition.

In a typical large American city the refuse problem required the ultimate disposal of the following materials: Ashes, rubbish, garbage, manure, street refuse and trade refuse.

In the smaller cities garbage and rubbish assume a larger relative importance. These refuse materials are disposed of in a number of ways, of which the following are typical:

(a) Most of the street refuse and ashes, with much rubbish, is taken to dumps. Measured by quantity, by far the larger portion of a typical city's refuse is dumped.

(b) Manure (stable refuse) is mostly transferred to farms and truck gardens, but some of it frequently reaches the dumps.

(c) There is nearly always some sal-

vage, chiefly of rubbish. This is often done by scavaging dumps, but sometimes in specially built plants.

(d) Hotel and restaurant garbage is generally fed to hogs, or rendered for grease and tankage. Relatively inert trade refuse is dumped. Thus the accessibility of dumps (or loading stations) affects the cost of industrial output.

(e) A variety of special methods of disposal have been developed for garbage, sometimes with the admixture of rubbish, ashes and other refuse materials.

Thus, for a typical condition, we find disposal by dumping used for as much of the refuse as can be dumped without creating objectionable conditions, with special disposal works developed for the rest. There appears also to be in some cities a tendency to increase the proportion of refuse dumped either on land or at sea, sometimes resulting in the abandonment of the specially developed works.

The location and accessibility of dumping grounds is, however, a direct factor in the cost of collection and haul, and dumps gradually become permanently exhausted from refuse disposal. Cities should, therefore, give careful consideration to their dump resources, with particular reference to the collection service and to other matters of disposal which decrease the amount of refuse to be dumped.

A Yard Stick for Haul.

The matter of haul may, therefore, have a determining influence on the development of special methods of disposal and the conservation of dumps, and it is therefore necessary to set up a measure for the relative value of haul. Local conditions will largely make up such a yard stick, but the effect on collection service and cost is one of the chief factors. Some data on the rate of collection work is given in Table 1. As an average figure for a typical large city, let us assume that a collection unit of two men can make collections of house refuse at the rate of 75 pickups per hour. If the unloading point is so located as to require four hours of haul, each such collection unit will serve around 300 houses per working day. If the team haul be reduced to three hours, the number of pickups (or houses served) will be increased to 375 per day. Under some local conditions the team haul requires as much as five hours time.

In larger cities the team haul can be supplemented by quantity haul. If the team haul (averaged with collection service) costs $4.50 per ton, quantity haul may cost only a third time as much, or about $1.50 per ton. What then is the economical relation between team haul and quantity haul? Obviously this can only be determined after a careful study of all the local conditions, including the rate of collection work, the travel of teams and motors, the available locations for transfer stations, the life and location of dumps and disposal plants, rates of wages and other similar considerations. But the yard stick for haul is the number of houses to which collection service can be given by a unit of collection and haul equipment. With due regard to the life of disposal works and to sanitary conditions, the work of collection and haul should be planned to serve the maximum number of houses per day.

London Reports.

During the last 5 or 6 years the refuse disposal of the Administrative County of London has called for special study largely through increasing costs of haul. From a population of almost four and one-half million it is estimated that about 5,000 tons of refuse per day require disposal. The county is divided into 28 metropolitan boroughs and the city of London, making 29 divisions in all. The following figures show the proportions in which the various methods of disposal are used:

Method of Disposal.	Number Borough.	Percentage of Refuse by Weight.
Barges to Dump.....	22	44.66
River to Dump.....	13	16.66
Incineration	14	18.66
Other Methods	17	20.00

This data is taken from the very complete final report (1921) of the conference of Metropolitan Borough Councils, of which Mr. J. T. Watson was Chairman. Other methods of disposal include local dump, sorting for sale, etc. From these figures it appears that practically 80 per cent of London's house refuse is at present disposed of by dumping. A few quotations from the conclusion of the conference are of interest to municipal officials in this country as follows:

"(a) *Dumping on the Land.*—The system of dumping crude refuse on low-lying land in disused clay-pits and in quarries, although at present the principal means of refuse disposal, will, we believe, be generally condemned for public health reasons if for on other.

"From the point of view of public health no word can be said in favor of dumping crude refuse. Nearly all rural authorities strongly object to land in their areas being used for this purpose (although they may adopt the same means of disposal), chiefly owing to the fact that at most dumps there is no organized method of covering over

the top surface with suitable material, and no attempts are made to bring the land back into cultivation. Consequently there is a continual risk of nuisance being created by fermentation and the dump becomes a breeding ground for flies and rats.

"(b) *Dumping in the Sea.*—This proposition has been put to us, and while, if it could be assured that there would be no return of the material with the tides, the system would have the merit of being sanitary, the cost of the necessary transport to riverside wharves and sea hoppers removes it, we think, from the sphere of practicability. There is also the possibility of long delays owing to unfavorable weather conditions.

"(c) *Burning in Destructors.*—Refuse destructors have been in existence many years, and they have the undoubted advantage of disposing of the dangerous elements which develop in refuse when left to ferment and decompose.

"As regards the utilization of the waste heat, this is of value for the driving of machinery for small subsidiary undertakings, such as a mortar mill, slab making or a small electric light plant, but it appears that the variability in degree of heat produced by a destructor and the comparatively small portion of the 24 hours that it works, renders the application of the heat generated much less desirable for purposes of a power station than heat raised by ordinary fuel.

"It is our opinion that the part to be placed by the destructor in the future will be, not the burning of all refuse, but that part of which no further use can be made.

"(d) *Pulverizing or Crushing.*—The Borough of Bermondsey installed four refuse crushers in the year 1919 on the river front. The plant deals with 320 tons per week, or 16,640 tons per year. The present cost of crushing at Bermondsey is 6s. per ton owing to the high rates of wages now paid. The staff consists of 12 men and 1 foreman. Their wages represent 51.88 per cent of the total cost of crushing. The Borough Engineer informs us that there has not been an extensive sale of the material and the Council have paid a small charge to the contractor for removing it.

"(e) *Salvage of Usable Constituents of Refuse.*—The suggestion was made at one of the meetings of the conference that Mr. J. C. Dawes, Inspector of Public Cleansing of the Ministry of Health, should be invited to give us his assistance in our task. This was done. Mr. Dawes has attended most of our meetings, and we are indebted to him for much valuable information concerning the activities of provincial local authorities in the matter of refuse disposal, and with regard to the great possibilities connected with the salvage of refuse and the installations that have been set up in various parts of the country for the treatment of refuse for subsequent use. But, although unsorted refuse is objectionable and would soon become dangerous to health, the fact remains that practically every one of its component parts separated from the remainder is a usable and useful commodity.

"Salvage plants are still in their infancy, and we do not give any details as to capital costs owing to the variations possible, according to the extent to which it is desired to sort the refuse and the manner in which the residue after sorting is disposed of.

"The cost of erecting on a provided site a plant capable of dealing with from 20,000 to 40,000 tons of refuse per annum may be estimated at about £15,000. Allowing for repayment of capital and interest and for running expense and taking only a moderate estimated return on sales, a very considerable saving can be shown over present-day costs of barging or railing to dump.

"It is not suggested that destructors and other systems of refuse disposal showing some return on working should be scrapped, but it is suggested that in some cases (and they are the majority in London) where refuse is barged or railed to dump in its crude state, the Councils concerned would be well advised to give the closest and most serious consideration to the possibilities of salvage."

Mr. C. Newton Russell, chief electrical engineer to the London Borough of Shoreditch, has likewise submitted thorough going reports on this subject. He states that—

"The main defects in the present system are expense, inconvenience and annoyance, necessitated in destroying refuse in the center of densely populated areas, owing to:

"(1) Flue dust troubles.

"(2) Congestion of traffic.

"(3) Increased cost of disposal of residue, which has risen from 2 per cent per ton in 1897 to 5 per cent per ton in 1917, and is still increasing.

"(4) Want of space to deal efficiently with by-products, such as:

"Flue dust.

"Old tins and metal.

"Bones, paper, straw, etc.

"And the utilization of burn residue for the manufacture of paving slabs, mortar, bricks and road material."

He then outlines a constructive program in a suggestive way as follows:

"In order to destroy and to deal efficiently with domestic and trade refuse, special types of furnaces are required, which it is impossible to have in small local plants. The remedy for this is, in the author's opinion, centralization, and in order that these notes may not only be of a negative character, and only critical, but rather of a constructive nature, with a view to increased economy and efficiency, as well as provision for the future, the following suggestions are put forward:

"1. Collection of refuse; depots for tram and water.

"2. Centralized destructor plant.

"3. Conveyance of refuse and return of by-products.

"4. Selection of site or sites.

"5. Layout of plant, sidings, workshops, offices, workmen's dwellings, etc.

"6. By-product department.
Research department (chemists).
Generation of steam.
Disposal of residue.
Manufacture of concrete or lime clinker blocks.
Clinker for road-making.

"7. Financial aspects."

After suggesting a further development of sorting he offers a tentative scheme that—

"London should be divided into, say, four districts, with a central destructor plant on the outskirts of each area, and preefrably with river frontage. As an illustration, take the eastern area from Shoreditch eastward. A site could be obtained on the river front at Barking, or lower down. It should be connected to the local tram and rail system so that the refuse trucks could be run right into the works. The area of the site should be ample enough to provide for—

"Plant to deal with 2,000 tons per day.
"Electric generating plant.
"Repair workshops.
"By-product works for making:
Crushed and ground clinker.
Mortar.
Concrete slabs, etc.
Workmen's dwellings.

Some American Conditions.

It should not be considered that English and American problems are similar. There are differences in the per capita production of refuse, in personal habits, in population densities and the like. Moreover, refuse disposal in America is in process of development. Minneapolis, under the guidance of Mr. Engberg, City Engineer, and Mr. Jensen of the Water Department has recently built loading stations to shorten haul; has motorized its garbage collection, and is considering an increase of incinerator capacity.

Mr. John Kloren, City Engineer of New Orleans, has developed disposal by incineration only after a most careful study of haul economics. Chicago, with the lake front still available for dumping, is feeling the pinch of filled-up dumps and longer hauls. Indianapolis has developed a tractor-trailer system for ash collection to decrease the increasing costs of collection and haul. The conditions now in London and in some American cities may come to other cities before many years. There is a limit in most cases in built-up communities to the nearby dump. Special methods of disposal and a comprehensive general plan for collection and haul are the necessary steps if service to householders is not to be curtailed. The wise communities are planning now the conservation of dumps.

What About Failures?

As commonly considered the term "failure," as applied to refuse disposal projects, refers to the abandonment of a finished disposal plant representing invested capital and ready for operation. If a considerable sum of public money is put into work, and these works are not used, but are allowed to disintegrate, something is certainly wrong. Many will say that such occurrences are rare, if not unknown. Let me name a few cities where some such upsets have occurred for part or all of the refuse: New York, Buffalo, Minneapolis, Chicago, San Francisco, Los Angeles, Seattle, Gary, Fargo, Madison and others. Such upsets, however, are not the real failures. They are the symptoms of a deeper trouble. I offer for consideration some of the causes of these upsets and plant abandonments as follows:

(a) A failure, in the first place, on the part of city officials, to appreciate the true measure of a refuse disposal project. Communities should understand that the first objective is a city of clean houses, with the construction of a disposal plant secured.

(b) A failure to secure and adopt a general plan for all the refuse disposal work, including proper ordiuances and kitchen cards, collection equipment and management, transfer stations, hauling

equipment, dumping facilities, disposal work and the like.

(c) Failure to profit by co-operation with experts of independent judgment who can bring to the local problem the helpful experiences of other situations acquired through years of study and participation.

Summary.

A review of refuse disposal practice, including some of the mistakes which have been made, clearly indicates the need for a broader development in the solution of the problem. The final objective of a clean city should stand out and be accomplished through a sound, general plan, based on experience with tried methods, economically operated. The complexity of the problem is obvious.

There are four principal elements to deal with and three to be satisfied, including householders, the public and the operation and its economy. Between these four factors, namely, house treatment, collection, haul and final disposal and the three elements to be satisfied, there appear to be nineteen different relationships. Thus collection is not only influenced by the house treatment and haul, but also by items of cost in operation, public considerations, methods of final disposal and the like.

Out of these various relationships there is some combination of house treatment, collection, collection equipment, transfer stations, haul, disposal plants, dumps, sites and locations, business management and accounting, which will produce the most favorable solution. Like all major engineering problems, but in a marked degree, the refuse disposal problem is one which canont be reduced to mathematical calculation, but must be solved on a basis of experience by those who have had opportunity to study and co-relate this experience in a broad manner.

Table I—Rate of Collection Service

Data from office notes and field investigations, Pearse, Greeley & Hansen, September, 1922.

City.	Material.	Number of Houses Per Wagon Per Day.
Pittsburg	Rubbish	145
Rochester	Rubbish	167
Charleston	Garbage	250
Fargo	Garbage	210
Toledo	Garbage	275
Montclair	Garbage	300
	Ashes	200

The foregoing paper, by Mr. Greely, was presented at the recent annual meeting of the American Society for Municipal Improvements.

HIGHWAY BRIDGE RECONSTRUCTION POLICY IN PENNSYLVANIA

It will not be many years before the old narrow stone bridges crossing streams and ravines on State Highway Routes in Pennsylvania will have passed into oblivion and new structures, or rebuilt old ones widened to meet traffic conditions of today, will grace the highways in their stead.

Motor traffic has increased so amazingly within the past few years that the Pennsylvania State Highway Department has sensed the absolute necessity and importance of wider bridge structures on its road system, which will make it possible for automobiles, trucks and other vehicles to pass each other without danger of collision.

A recent survey made by the Department shows a total of 1,834 bridges less than 16 ft. wide—many of which cannot carry two vehicles at the same time—that are located on roads which have been made a part of the State Highway System. Under the law trucks are permitted a width of 90 ins. and, consequently, these old narrow structures constitute an ever present and serious menace to all users of the highways.

Plans now are being prepared to widen the more vitally important ones located on heavily traveled highways, so that when the working season opens up in the spring—and if the present financial resource for repairs is continued—operations may commence immediately. However, some of these structures were built 50 or 100 years ago and are in such condition that to repair them would not be economical, or advisable, and new construction is therefore necessary, while in some instances the cost of widening is prohibitive at the present time, so that contemplated changes will have to be held in abeyance until further appropriations are available for this purpose.

In the meantime the Department is exercising every precaution for the safety of the traveler and warning signs are being erected which read: "Danger! One-way Traffic Bridge."

The policy of the Department is to construct all new bridges with a width of at least 24 ft. and in the improvement of those which are not entirely rebuilt, according to a statement by Assistant State Highway Commissioner George H. Biles, "Every effort will be made by the Department to retain the contour and general architectural characteristics of the old

structures which are landmarks in the communities where they are located and in many instances replete with memories of personages and events connected with the early history of Pennsylvania."

NO DETOURS—ROAD UNDER CONSTRUCTION—DO NOT STOP

By George C. Warren, Chairman, Executive Committee, Warren Brothers Company, 9 Cambridge St., Boston, Mass.

What a blessing it would be if road construction generally were accompanied by a sign reading, "No Detours—Road Under Construction; Do Not Stop," instead of the customery barricade and "Detour" sign with hand pointing up a rough, dusty or muddy, unimproved road. How many miles the detour hand signifies the traveler knows not.

An article in the September issue of Municipal and County Engineering, "Detour Practice of Pennsylvania State Highway Department," gives some valuable thought by way of standardizing the signs and making them mechanically more desirable or permanent and indicating thereon some idea of the length of the detour, such as "To Lancaster via Columbia," but not a word regarding overcoming the annoyance and expense of such detours.

This expense is generally given scant consideration in the design and in contracting for highway construction. It not only involves generally immeasurably great expense to the tax-paying public in maintenance of detours, but probably even greater expense in additional maintenance of automobiles, to say nothing of the annoyance to motorists of plowing through dusty or muddy or over rough and rutted roads, often for several miles.

During the past year, in a Masschusetts town, in connection with awarding a contract for about one mile of road, one bidder, who was about $1,000 high, agreed to construct the work without detours, and at all times to permit normal traffic through the road under reconstruction and to complete the work in three weeks. The contract was awarded for the cheaper (?)

VIEW ON LOWER COLUMBIA RIVER HIGHWAY IN OREGON, BUILT IN 1915 WITHOUT CONSTRUCTION DETOURS.

A FEDERAL AID ROAD IN ARKANSAS COUNTY, ARK., BUILT IN 1920. NOTE FLOODED RICE FIELDS AT SIDE OF ROAD MAKING DETOURS IMPOSSIBLE.

type of road and the town thought it was saving $1,000. The thoroughfare was barricaded from traffic for over four months and the public obliged to detour more than two miles off the main highway. One of the town officials subsequently told the writer that the maintenance of the detour roads to keep them in passable condition cost the town over $2,000. Which was the cheaper bid?

Detours on country highways can be and very frequently have been entirely avoided, and that without in any way injuring the roads under construction and without discommoding either the contractor or traveling public. Four remarkable instances are shown in the accompanying photographs due to the contour of surroundings through mountainous and flooded country, to-wit: 70 miles of the Colum-

CAMP PIKE FEDERAL AID ROAD IN ARKANSAS. BUILT IN 1917, 10 MILES, NO CONSTRUCTION DETOURS.

bia River Highway (Oregon), constructed in 1915; 7.3 miles of the Ogden-Canyon road (Utah), constructed in 1920; Camp Pike Road (Arkansas), 10 miles, constructed in 1917, which, while under construction, carried the immense war period military traffic from Little Rock to Camp Pike, and a road through the flooded rice fields of Arkansas County, Arkansas, laid in 1920. Many similar instances could be given.

This cannot be accomplished by the laying of either base or surface of rigid material, which requires weeks or months to set before traffic can be allowed to pass over it. In the instances above referred to the foundations were of non-rigid types, which are not injured by passing traffic, namely:

Columbia River Highway, new compressed stone base; Camp Pike Road, old macadam utilized as the base for new surface; Ogden-Canyon Road, old macadam raised to desired contour and elevation by asphaltic concrete base. Particularly note that the illustration of this road shows a steam roller at work, as well as automobile, passing over the work while under construction. Arkansas County, Arkansas, new compressed stone base.

The wearing surface in all cases was of the Warren type, no part of which is damaged by passing vehicles either before or during the process of compression, and which is thrown open to traffic without even a watchman within five hours after the compression is completed, that is, as soon as the temperature of the road surface is reduced to that of the air.

OGDEN-CANYON FEDERAL AID ROAD, UTAH. BUILT IN 1920, 7.3 MILES. NO CONSTRUCTION DETOURS.

Construction News and Equipment

IOWA ROAD BUILDER MOUNTS CONCRETING EQUIPMENT ON RAILWAY CARS

Mounted on wheels from mixer to cook shack, one Iowa concrete road builder's outfit is ready at a word to pull up stakes from the job at hand and move at railroad speed to a new location, says a recent issue of the Service Bulletin of the Iowa State Highway Department.

Fully motorized and fully equipped with wheels, railroad wheels at that, most of the time, the whole camp can be en route in case of necessity or expediency in a few moments' time. On arrival at the new site with equal celerity it can be fully established and going at full efficiency. Incidentally, too, this is one of the most completely equipped paving outfits in Iowa. It has been consistently making a fine daily average of pavement actually laid.

When C. F. Lytle of Sioux City found that as a result of Woodbury County lettings he had in hand a 14-mile contract for concrete pavement, with two or three settings of an outfit necessary and with other jobs in prospect of rather short mileage, he determined to organize an outfit and design a plant and equipment so that as little time as possible would be actually lost in the necessary moving. A central proportioning and mixing plant was selected as best adapted for the work on hand and in prospect. A railroad flat car of ordinary type was one of the first purchases. One end of this was mounted a Lakewood mixer of 56 cu. ft. capacity per batch. On the other end the Wisconsin Model M gas engine was mounted, with a belted drive connecting to the mixer. The engine was housed in with a wooden cabin for protection from the elements. Fabricated steel was used to build a frame work about the mixer to support the necessary hoppers above for sand and gravel, and with heavy bolted removable supports to rest upon the ground and give stability to the outfit. Two long canvas belt carriers extending directly along the car side at the back of the mixer provide two separate elevators for the cement, which is dumped from the sacks into the carrier hoppers from the cement supply cars at either end of the mixer car. The cement carriers are necessary to keep an unbroken supply of material. When working at full capacity one carrier with one crew emptying cement sacks into the hopper at the bottom cannot supply the mixer. Fourteen full sacks of cement are required for each batch. The two carriers also make unnecessary a complete shut down of the mixer equipment while one cement car, after being emptied, is run out and the new one brought in.

A locomotive crane is one of the handiest and busiest pieces of equipment about the plant. The crane unloads the sand and gravel from the supply cars into the reserve stock pile. It keeps the hoppers at the top of the proportioning bins filled and ready for dumping as each new charge is required. When cars need to be shunted about, it does the shunting. If the cook shack and dining cars are to be moved or a load of lubricating oil or gasoline brought in from the side track, where the freight train crew left it, is not necessary for this Lytle plant to wait until the local freight comes through next day to have the job done. The crane simply swings its long boom into line and is ready for business as a freight engine. It does all of the odd jobs about the camp which are too big or too heavy for the trucks to do, and it is busy practically every minute of the day.

But the real show part of the Lytle camp equipment is the line-up of Kissel trucks when they report in from the final trip of the day or for the noon meal. These special Kissel road builders' trucks are equipped with automatic hoists and pneumatic tires. These trucks, moreover, are no juvenile affairs. They are high powdered, of mammoth size and carry huge loads. For instance, the single batch of wet concrete they carry weighs over four tons and the front tires are 36x6 ins. and the rear tires are 44x10 ins. A Ford casing, it seems, could be thrown through the opening in one of these casings without touching the larger one. Placed side by side the Ford tire looks like a toy. The entire equipment alone, on this set of trucks, represented when new an outlay of $20,000.

A fully equipped repair shop with competent foreman and several mechanics is maintained to keep the trucks and the balance of the equipment in the best condition at all times. When a truck has tire or any other trouble when out on the road the first truck passing him carries the word to the repair shop and a service truck, fully prepared, if possible, to meet the needs of the emergency at hand, makes the run with very little loss of time. If the repair can be made on the spot by the roadside in short order it is unnecessary usually to switch the load of wet batch concrete to another truck. If the repair requires too much time, the batch is usually transferred and carried on to its destination. Very few loads of material have been lost because of the delay of a truck while en route with its load. The trucks, even when loaded, travel at a high rate of speed and the wet concrete batch has been successfully transported a distance of eight miles without detriment. The entire round trip at the time the eight-mile run was being made took approximately one hour. So carefully have the mechanical needs of the trucks and other equipment been looked after by the repair shop and its force of men that in four months' time practically no delay has been experienced on account of having to make repairs on equipment during working hours.

A Lakewood sub-grader is used to shape up the grade and a finishing machine of the same make shapes, tamps and gives the finishing touch to the concrete slab. This machine is followed by hand finishers who complete the work of surface finishing, build the sloping intergral curb on steeper grades and the special design drainage intakes. These latter are built into the edge of the slab at the curb line.

Caring for its equipment does not absorb all the attention of the company. To keep the men satisfied and contented on the job has been one of the features which has led to the good construction record made by the company.

To house the kitchen and dining room two box cars of the Palace horse car type were purchased. One was entirely rebuilt inside and equipped, at one end, with a complete camp kitchen outfit. This contains all supply bins, shelves and refrigerator. The balance of the car not needed for the kitchen was rebuilt as a small dining room. The second car was entirely equipped as one large dining room. It is possible to seat comfortably, in the two rooms, a total of 75 men at one time. Sleeping quarters for the men are provided in tents or frame buildings if the latter are available or the time on the job seems to warrant. A special cook shack and sleeping quarters are provided for all colored help on the job.

The Lytle construction for 1922 for Woodbury County covers approximately 14 miles of concrete pavement in three separate projects. Primary road project No. 187 covers a little over one mile on road No. 23 in the town of Moville. Federal aid project No. 2 extends out from Sioux City limits about 5½ miles south on the road No. 34, the Sioux City-Denison road, sometimes called the Smithland Road. Federal aid project No. 136 extends south from Sergeants Bluffs to Salix on road No. 12 approximately 7 miles. This latter is called the Sergeants Bluffs road.

Thirteen days' work on the Sergeants Bluffs road netted in actual accomplishment an average of 718 ft. of complete pavement laid, an average of 1,436 sq. yds. of concrete slab 8 ins. thick and 18 ft. wide, or 320 cu. yds. of material actually placed on the road.

Fifteen days' work on the Smithland Road netted an average of 620 ft. of pavement slab laid per day, 20 ft. wide and 8 ins. thick, an average of 1,376 sq. yds. of road surface covered, or 340 cu. yds. of material placed.

Twenty-five days' work, also on the Smithland Road, but of 18 ft. width pavement, averaged 850 lin. ft. per day of roadway, 1,700 sq. yds. of pavement slab, or 275.5 cu. yds. of material placed.

These figures are from daily reports of work accomplished.

Photographs of the camp and equipment show that considerable thought and time must have been given, not only to the design of the individual parts of the outfit, but to the general arrangement of the various units comprising the plant in order to facilitate the handling of materials. The one feature that marks this plant as distinct from other 1922 road building plants is the fact that every important individual unit of the equipment from mixer to cook shack can be almost instantly ready for transport from one point to another by reason of its more or less permanent mounting on railroad cars.

Mr. Lytle in 1921 built 17 miles of concrete pavement for Woodbury County on the Sioux City-Correctionville road. With the completion of his present contract he will have built 31 miles of pavement for his home county.

At left: Washington Heights, maintained with "Tarvia-B" since 1916.

"Tarvia-B" makes good in Newburgh—

Benkard Avenue, pictured in the circle, was the first Tarvia street in the City of Newburgh, New York. The results were so satisfactory that in 1916 other macadam streets were given their initial Tarvia treatments. Not until last year, however, when the 18 miles of roadway shown on the accompanying street map were surface-treated with "Tarvia-B", was the use of all other kinds of road-maintenance material entirely abandoned in favor of Tarvia.

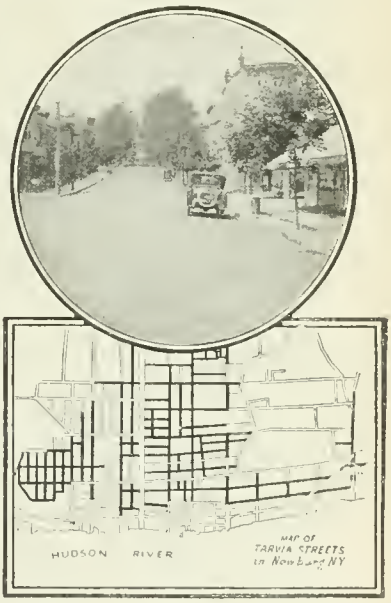
Mr. W. J. McKay, City Manager, wrote under date of March 17, 1922:

> "It is with a great deal of pleasure that I inform you that the results obtained from the use of your 'Tarvia-B' on the streets of this city last season were more than satisfactory.
>
> "While we are always in the market for material cheaper than the material we used the preceding season, it would take a considerable difference in price to have us make any change in the product to be used for the season of 1922."

Economy must be the goal of every conscientious public official. And the officials of Newburgh, and hundreds of other cities and towns throughout the country, have found from experience that Tarvia is the most economical of all road materials.

Above: Du Bois St., maintained with "Tarvia-B" since 1916.

Below: Benkard Ave., maintained with "Tarvia-B" since 1913.

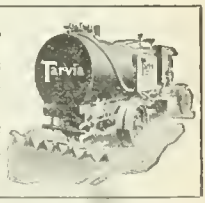


Tarvia

For Road Construction Repair and Maintenance

A Grade for Every Purpose

Tarvia is made in various grades for all road purposes—new construction, repairs and maintenance. An illustrated booklet telling of the different Tarvia Treatments will gladly be sent free on request.



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CONSTRUCTION PRICES NOT LIKELY TO DECREASE IN NEAR FUTURE

That construction costs will continue to increase to a higher level than at present, and that the demand for construction will continue for some years to come, is the opinion of the Associated General Contractors of America, in a statement made recently to James A. Wetmore, Acting Supervising Architect, who is quoted as authority for the statement that within the next 18 months the country may look for a very material drop in the cost of building.

In the *United States Advertiser* it is reported that $15,000,000 worth of Federal buildings throughout the country are being held up for a drop in the cost of construction expected within the next 18 months.

Not only has the cost of building been going up for several months, according to the Associated General Contractors, but so has the cost of materials. Wages in the building trades have more recently begun to increase also. The general average of wholesale prices has been increasing since the first of the year.

"The behavior of all these prices in increasing during a time of recovery from business depression," state the contractors, "is entirely normal. It is a phenomenon which always occurs during like periods. We believe it is a very strong indication that prices in general have been stabilized for the present on a new price level in the neighborhood of 70 per cent higher than that which prevailed in 1913. This means that prices will continue to go up until the present period of prosperity is fully established and will not go down again until the beginning of the next business depression. The next depression will probably be only a moderate one, such as we were familiar with before the war, and will be accompanied by only moderate decreases in prices.

"Instead of expecting that building costs will be materially lower 18 months from now, we anticipate that they will continue to increase during the greater part of that period, and that they will be at that time, perhaps, at about the beginning of a decrease, but at a point higher than the present. We believe further that the decrease which may be expected to begin at about that time will not go to a point very much below the figures reached during the past winter."

In explaining their reasons for their opinions, the contractors say that the costs of building materials are going up partly because they are partaking of the general tendency of prices to rise during this part of the economic cycle, and partly because we are experiencing a building boom of unprecedented volume. Wages of building labor are increasing partly because of the shortage brought about by this same building boom and partly because of a recovery in other lines of industrial activity, which is already beginning to produce labor shortages.

"One important aspect of this phenomenon," they state, "is the shortage of common labor, which is due, in large measure, to the almost complete extinction of immigration for the past nine years, caused first by the Great War and latterly by our preesnt restrictive immigration act. That this shortage of common labor in fields other than the building trades is a very real one is proved by the recent action of the United States Steel Corporation, and a number of the other important steel companies, in making large voluntary increases in their wage scales.

"It may be that some believe the present building boom has about run its course, and that for that reason building activity will soon diminish and building costs go down. We believe the outlook to be far otherwise. The boom shows no signs of abating. For six successive months the figures for contracts let have been record-breaking. The slight recession of August is less than the usual seasonal recession. As a result of very painstaking investigations it has been estimated that the deficit in building, the country over, is so great that building could continue for ten successive years, beginning with this year, at 25 per cent above normal before catching up with that deficit. We do not predict any such sustained activity, but we do point to the figures as proof that there is no possibility of the present building boom coming to an end within the next few months, because of having completely filled the demand for new construction."

THE AUSTIN NO. 12 DRAGLINE

The Austin No. 12 Dragline, shown in the accompanying illustration, embodies in its design and construction many features which are sure to meet the approval of engineers and contractors.

In general the excavator is of the full revolving type and is mounted on two multipedals. A 6-cyl. heavy duty type gasoline motor provides 250 h. p. at 425

R. P. M., which power is more than ample to drive the machinery under all circumstances. Semi-diesel engines can be substituted if necessary.

An air compressor and storage tank, the former operated through a direct connection to the main motor, provides air for the air rams which control the drag and hoist drums, the swinging mechanism of the machine and an air starter for the main motor.

Since machines of this type are worked continuously day and night, powerful electric lights are installed, so that the work of excavating can proceed without interruption.

Extra large multipedals provide in a machine of this class a hitherto unequalled bearing pressure of 1,150 lbs. per sq. ft., which is sufficient to enable the machine to travel on its own power over extremely

THE AUSTIN NO. 12 DRAGLINE.

soft surfaces without the use of mattresses or artificial supports of any kind. Standard equipment is 2½ cu. yd. Page bucket and 60 ft. boom. Longer booms and smaller buckets or shorter booms and larger buckets can be furnished.

This type of machine, on account of its adaptability for swamp work, is now giving an excellent performance on reclamation work in Florida. The machine is extremely mobile, having a low speed forward of ½ mile per hour, and a high speed forward of ¾ mile per hour. The wide-faced multipedals enable it to travel over the Everglades quickly and without miring. The machine is very fast in operation and records of 2,400 yds. in ten hours have been made with it. As an example of the painstaking care exercised by the manufacturers in their efforts to produce a machine finished in every detail, it might be of interest to add that an electric fan has been provided on machines going into hot southern climes, which serves both to cool the operator and blow mosquitoes away. These machines are manufactured by the Austin Machinery Corporation, Dorr St., Toledo, O.

THE 1923 GOOD ROADS SHOW

With the early start that was made during the summer through a partial reorganization and an election of officers in the American Road Builders' Association and the creation of the Highway Industries Exhibitors' Association to bring about closer co-operation, arrangements are rapidly being perfected for the Thirteenth American Good Roads Congress and Fourteenth National Good Roads Show to be held in Chicago, January 15, 16, 17, 18 and 19, 1923.

The early beginning has enabled those in charge to perfect a working organization so harmonious and effective that conditions nearly 100 per cent perfect are assured for the next big double event. While many of the most important features of both congress and show will be retained, others both new and novel will be added.

It is the intention to separate the congress and show by holding the former at the Congress Hotel and the latter, as usual, at the Coliseum. It is believed this arangement will be more satisfactory, as it will obviate the necessity of shutting down the operating machinery during the sessions, and will eliminate the noise that has proved so annoying to speakers and delegates at the convention. The new arrangement is also expected to increase the attendance at each session of the congress.

Shortly after his election, Thomas J. Wasser, president of the American Road Builders' Association for 1922-1923, appointed to the Executive Committee the following: Charles M. Upham, state highway engineer for North Carolina; James H. MacDonald, consulting highway engineer, New Haven, Conn., and J. H. Cranford of the Cranford Paving Company, Washington, D. C. By reason of his position as secretary, E. L. Powers became ex-officio a member of the committee.

This committee, acting for the A. R. B. A,. appointed Messrs. Upham and MacDonald, and the Highway Industries Exhibitors' Association designated its president, S. F. Beatty, vice-president of the Austin-Western Road Machinery Company of Chicago, to act as a committee having general charge of the arrangements for

both the show and the congress. The committee is known as the Convention and Show Committee.

This committee has now created several sub-committees to have charge of the various detailed arrangements as follows: Transportation Committee, Royal M. Allen, chairman; General Publicity Committee, S. T. Henry, chairman; Chicago Press Committee, W. R. Harris, chairman; Exhibitors' Committee, C. R. Ege, chairman; Entertainment Committee, A. C. Cronkrite, chairman; Reception and Hotel Committee, John B. Hittell, chairman; Registration Committee, L. S. Louer, chairman; Banquet Committee, Joseph R. Draney, chairman; Program Committee, E. J. Mehren, chairman.

The Exhibitors' Committee has employed a professional director of exhibits in C. W. Kelley of Chicago, who, though never before identified with the road show, has managed some of the biggest expositions in the country, and the Publicity Committee has re-engaged C. S. Lee of New York, who handled the publicity work for the shows and conventions in 1921 and 1922.

According to Chairman Upham, of the Convention and Show Committee, the chief difficulty will be encountered in providing space for all the exhibits, though arrangements will be made for all the additional space it is possible to obtain. "The Highway Industries Exhibitors' Association," said Mr. Upham, "is giving us splendid co-operation in working out the arrangements. We expect to conduct a publicity campaign of greater compelling force and more far-reaching effect than ever before, and I believe the attendance will break all records.

"The program for the Congress as it is being worked out by the Program Committee will be the exact reversal of our previous ones. Instead of avoiding controversial subjects, as in the past, the program next year will be made up almost entirely of controversial subjects of interest to the road-building industry as a whole. This, we believe, will greatly increase the interest in the program, and will provoke highly interesting and instructive oral discussions from the floor."

The American Road Builders' Association has opened new offices at 37 West Thirty-ninth St., New York City, the old ones at 11 Waverly Place having been abolished. Headquarters will also be opened in Chicago long in advance of the congress and show.

PERSONAL ITEMS

Edward E. Duff, Jr., newly elected Secretary of the National Paving Brick Manufacturers' Association, will assume office on or about January 1. Maurice B. Greenough, retiring Secretary, will become associated at that time with Mr. W. M. Lasley, of Chattanooga, Tenn., in various enterprises, including the manufacture of paving brick. Mr. Duff comes to the National Association particularly well fitted to assume charge of its increasing activities. Following several years of experience in railroad engineering with the Pensylvania

EDWARD E. DUFF, JR.

Railroad, he spent several years in municipal engineering and management at Sewickley, Penn. When the United States entered the war he was commissioned and served for two years with the A. E. F. in France as Captain of Engineers. This, with his subsequent experience as field engineer for three years with the Eastern Paving Brick Manufacturers' Association, places him in a position where he can be of service in the street paving and highway construction field, as well as in the paving brick industry. Mr. Duff is a graduate of the Department of Civil Engineering of Carnegie Institute of Technology, where he was awarded the degree of B. S.

in C. E. in 1913, and in 1917 the degree of C. E. He is an associate member of the American Society of Civil Engineers and a member of the American Society for Municipal Improvements, the Society of American Military Engineers and the Engineers' Society of Western Pennsylvania.

C. A. Jennings, District Sales Manager for Wallace & Tiernan Co., Inc., at Chicago, resigned, effective Nov. 1. He has taken offices in the Monadnock bldg., Chicago, and will act as manufacturer's sales representative for the Michigan Valve and Foundry Co. of Detroit; Roberts Filter Mfg. Co., of Darby, Pa.; Universal Destructor Co., of Pittsburgh, and other firms manufacturing water works and sanitary engineering equipment.

At the annual meeting of the Milwaukee section of the American Society of Mechanical Engineers, Will J. Sando was elected chairman for the ensuing year. Mr. Sando was a member of the Board of Managers of the American Society of Mechanical Engineers from 1908 to 1911. Mr. Sando is an internationally known engineering expert. In the year 1900, when he left Boston, he was superintendent of pumping stations of the Metropolitan Water Board of the Commonwealth of Massachusetts, and later chief engineer of the Water Works and Condenser Department of the International Steam Pump Company, New York; engineer of the Department of Pumping of the Commission on Additional Water Supply for the City of New York, and manager of the Pumping Engine and Hydraulic Turbine Department of the Allis-Chalmers Manufacturing Company, Milwaukee. Since 1910 Mr. Sando has been in private practice as a consulting engineer at Milwaukee.

Weston E. Fuller has withdrawn from the firm of Hazen, Whipple & Fuller, Civil Engineers, 30 East 42nd St., New York, to become professor of civil engineering in Swarthmore College. The firm name is changed accordingly, and again becomes Hazen & Whipple, which was the name from 1904 to 1914, inclusive. All the other partners remain in the firm. Prof. Fuller will continue the active practice of civil engineering, and Mr. E. W. Doebler, formerly with Hazen, Whipple & Fuller, will be associated with him in this work.

Abel Wolman was elected Chief Engineer to the Maryland State Department of Health on Sept. 21 by the State Board of Health, to succeed Robert B. Morse, resigned. Mr. Wolman will continue his activities as lecturer in sanitary engineering in the Johns Hopkins University School of Hygiene and Public Health and as editor of the Journal of the American Water Works Association.

MICHIGAN GRADUATE SHORT COURSES IN HIGHWAY ENGINEERING AND TRANSPORT

(Editor's Note—Following is the schedule of the 1922-23 Graduate Short Period Courses in Highway Engineering and Highway Transport which will be offered by the University of Michigan during the Winter period, Dec., 1922, to March, 1923. This is the only institution offering such courses for credit towards advanced degrees. The attendance on these courses has steadily increased during the past three years, as indicated by the following data: 1919-1920, 29 men; 1920-1921, 45 men, and 1921-1922, 94 men. The average age of the men in attendance last winter was 27 years, varying from 22 to 54 years. They came from national, state, county and municipal highway departments, consulting engineers' offices, contractors' organizations, university faculties, companies manufacturing highway materials and machinery and the field of highway transport. Last June the University conferred 16 Master's degrees on graduate students specializing in highway engineering or highway transport. The Board of Regents, in recognition of this rapid development, has assigned to the division of Highway Engineering and Highway Transport 26,000 sq. ft. of working space for the Davis Library of Highway Engineering and Highway Transport, offices, graduate lecture rooms, drafting rooms and laboratories in the new $750,000 engineering building:)

Dec. 4 to 15, 1922.

C. E. 77.—Highway Engineering, Financing, Management and Organization.—Professor Smith.

C. E. 81.—American and English Highway Transport Methods.—Professor Blanchard.

Dec. 18 to 30, 1922.

C. E. 67.—Highway Transport Economics and Surveys.—Professors Blanchard and Smith.

C. E. 72.—Gravel and Broken Stone Roads, Dust Prevention and Bituminous Surfaces.—Professors Blanchard and Smith.

Jan. 1 to 12, 1923.

C. E. 73.—Brick, Cement-Concrete, Stone Block and Wood Block Pavements.—Professor Bateman.

C. E. 80.—Interrelationship of Highway, Railway and Waterway Transport.—Professor Riggs.

Jan. 15 to 26, 1923.

C. E. 69.—Highway Laboratory Research.—Professor Bateman.

C. E. 70.—Highway Structures.—Professor Gram.

C. E. 82.—Highway Transport Costs and Record Systems.—Professor Smith.

Jan. 29 to Feb. 9, 1923.

C. E. 68.—Bituminous Macadam, Bituminous Concrete and Sheet Asphalt Pavements.—Professor Blanchard.

C. E. 84.—Highway Transport Management.—Professor Smith.

M. E. 40.—Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers.—Professor Lay.

Feb. 12 to 16, 1923.

Ninth Annual Michigan Conference on Highway Engineering.

Feb. 19 to March 2, 1923.

C. E. 71.—Highway Specifications, Contracts and Jurisprudence.—Professor Riggs.

C. E. 79.—Highway Transport Legislation and Traffic Regulations.—Professor Blanchard.

March 5 to 16, 1923.

C. E. 75.—Highway Engineering Seminar.—Professors Blanchard and Bateman.

C. E. 76.—Highway Engineering Theory and Design.—Professor Smith.

C. E. 78.—Earth and Sand-Clay Roads and Grading Machinery and Operations.—Professor Bateman.

C. E. 83.—Highway Transport Seminar.—Professors Blanchard and Smith.

A PORTABLE SAND AND GRAVEL DRYER

The Littleford Sand and Gravel Dryer No. 12, here illustrated, makes possible the heating and drying of sand and gravel without the need of mechanical equipment. No skilled labor is required to operate it and there is no cause for expensive delays which are incidental to mechanical dryers.

The operation of this dryer is quite simple. The material to be dried is filled in at the top and comes in contact with a heated arch plate over the furnace. As the material dries, it flows from the convex surface of the arch plate to ledges on both sides of the dryer. Perfectly dry and heated material is removed from these ledges as needed.

The construction is very durable. The shell and furnace are made of 3-16-in. steel. The firebox is all ¼-in. steel, with ¼-in. renewable steel liner plates. The arch plate is made extra heavy of ⅜-in. steel, with heavy stiffeners to prevent warping.

The furnace shell, which extends the full length of the dryer, has a firebox of

THE LITTLEFORD NO. 12 SAND AND GRAVEL DRYER.

ample proportion at the rear and which is fitted with heavy cast iron renewable grate bars. It is also fitted with an improved type of cast iron fire door. The ash pan under the grate is built integral with the firebox.

The dryer is mounted on all steel wheels, with wide tires and staggered spokes. Axles are tapered and machine turned. This dryer is manufactured by Littleford Bros., 460 E. Pearl St., Cincinnati, Ohio.

GARAGE OF INDIANA STATE HIGHWAY COMMISSION

The big garage of the Indiana State Highway Commission, where hundreds of motor vehicles, consisting of trucks, touring cars, roadsters, trailers and motorcycles are kept in repair, often completely rebuilt, is held as a model of efficiency by numerous state high commissions of the Middle West, who have sent their shop foremen to Indianapolis to get a close-up, so to speak, of how it operates under the guidance of George N. Bartley, superintendent of the motor transport.

The Ohio Highway Commission has sent its transportation chief (J. T. Shafer) here on two occasions, and D. H. Cornell, of Springfield, head of the Illinois State highway transportation system, writes that he is sendiing his garage superintendent here to learn the methods of rebuilding cars as carried on at the Indiana Highway Commission's garage. According

to John D. Williams, director, the transportation heads of half a dozen state highway commissions have visited the Indiana garage in the last few weeks.

When it is recalled that the bulk of equipment worked upon at the state garage consists of cars and motors formerly in war service, the major portion of them have to be rebuilt and all have to be torn down, cleaned and reassembled, it is readily seen that the task of keeping this rolling stock in condition for maintaining several thousand miles of state roads is no slight one.

Frequently garage mechanics figure out new parts which they make and eliminate the purchase of expensive stock parts. A recent illustration of this was the manufacture at the garage of an attachment for the rear part of a big truck of certain design which functions properly and does away with the universal joint. Tests prove the new device strengthens the truck. Mr. Bartley explains that the new device is manufactured in the state garage for $10, and the cost of a new universal joint is $53.

NEW CROSS SECTION FOR ILLINOIS CONCRETE PAVEMENTS

The following announcement pertaining to the new cross-section for concrete pavements on Illinois state highways was recently issued by Frank T. Sheets, Superintendent of Highways, and Clifford Older, Chief Highway Engineer of the Illinois State Division of Highways:

This cross-section provides for a thickness of 9 ins. at the edges of the pavement, tapering to 6 ins. at a distance of 2 ft. from the edges. The remainder of the pavement is to have a uniform thickness of 6 ins. The amount and arrangement of reinforcement is to be the same as that heretofore used, with the exception of the center joint material, a new design for which has been provided to correspond with the 6-in. center thickness.

This new cross-section was adopted as a result of the Bates road tests, which show conclusively that the strength of the edges of any rigid pavement, built in accordance with any design heretofore used, is much less than the strength of the interior portion of the slab.

The Bates' tests disclosed the fact that a center thickness of 6 ins., or even perhaps 5 ins., is ample to support the legal load limit provided by Illinois statutes. The new cross-section takes advantage of this fact. The tests further indicate that even with a 6-in. thickness for the main portion of the slab, a 7-in. edge with the ¾-in. longitudinal bar would still not be as strong as the mid-portion of the slab. The edge thickness has, therefore, been increased.

Particular attention is called to the fact that the new cross-section provides 1 sq. ft. less of cross-sectional area than a slab having a 7-in. uniform thickness. This means that the new cross-section will require 195½ cu. yds. less of concrete per mile of pavement than the standard 7-in. design heretofore used.

The Department believes, therefore, that the new cross-section will provide a pavement which not only is better able to support trucks loaded to the legal limit, but will also reduce the cost per mile.

At first sight it might seem that the cost of shaping the sub-grade to accommodate the new cross-section would be troublesome. A little consideration, however, will indicate that the extra cost would be very small, as sub-grading machines may easily be adapted to cut the sub-grade to the new form. Even should the sub-grade be cut to the usual crown, at an elevation of 6 ins. below the top of the forms and the dirt along the edges is then thrown out by hand, it may be seen that the additional cost of shaping the sub-grade would be but a small item.

Contractors are earnestly requested to consider this new cross-section carefully, in order that we may co-operate as heretofore in building the best and the most durable roads with the least expense to the State of Illinois.

PAVING GARY (IND.) SECTION OF DUNES HIGHWAY

Good progress is being made in paving the Dunes Highway near Gary, Ind., where for a mile and a half the road passes through a marsh. The contract for 7 miles is held by the General Construction Company of Gary. When this company started through the marsh to make a fill for the right-of-way, it was necessary to dredge out and remove many tons of muck and vast quantities of decaying vegetation, before the fill could be built from sand, on which the concrete pavement is laid. Many difficulties were experienced in making this fill, according to Mr. Moe, superintendent of the construction company, chief of which was

getting machinery and equipment across the swamp onto the right-of-way.

Parts of this preliminary work necessitated crossing the swamp with a 30-ton dredger, caterpillar type. At one place the big machine mired, and to get it again on firm ground it had to be hauled out by an interurban motor car. A long steel cable was procured at Chicago, and by means of this cable the traction motor, operating on the interurban line, which parallels the highway, and is only a short distance away, was able to extricate it. The job cost $1,000, Moe says.

The Dunes Highway is approximately 20 miles long, and is almost an air-line route between Gary and Michigan City. It is destined to be one of the most heavily traveled highways in the Indiana state road system, as it will care for traffic between Chicago, through Gary, Indiana's chief steel city, to Michigan City, a famous summer resort, and farther east it will connect with a state road through Michigan and thence through eastern states to the Atlantic seaboard.

The construction of the Gary end is considered the most unique road-building project in Hoosier highway construction, and is being watched by highway engineers in all parts of the country. Many have visited the project. Difficulty in obtaining right-of-way and also materials, the latter due to industrial tie-up, prevents the entire 20 miles of pavement being laid this year. However, most of it will be completed and the remaining gaps closed next spring.

PROGRESS ON IDEAL SECTION OF LINCOLN HIGHWAY

That progress in the construction of the Ideal section of the Lincoln Highway was considerably delayed by the railway strike, and the resulting cessation of material shipments, is announced by the Lincoln Highway Association.

This famous piece of road between Dyer and Schererville, in Lake County, Indiana, the design and construction of which has probably received more thought and care than any other section of road in the world, is being built by the Association to demonstrate what is believed to be the last word in modern, durable highway specifications for main routes of heavy travel. While the stretch is not long, being less than a mile and a half in length, it is being constructed with the utmost care and under the combined supervision of the Federal Government, the State of Indiana and the Lincoln Highway Association. Every safeguard is being thrown around the work, to the end that the completed paving may be in every respect as perfect as modern highway engineering can produce. The work is therefore not being unduly rushed.

W. G. Thompson, Consulting Engineer for the Lincoln Highway Association, and representing also its Technical Committee of highway engineers and other authorities, recently inspected the progress of the work, following the resumption of material shipments. Following a conference with C. Gray, State Highway Engineer of Indiana, and Albert Scott, Vice-President of Lockwood, Greene & Co., Engineers, in charge of the work for the Lincoln Highway Association, he announced that no chances will be taken in laying any of the concrete pavement during cold weather. This means that the pavement will probably be completed from the west end of the section to the bridge this year and the balance of the paving, toward Schererville, be postponed until Spring. The old macadam now extending west of Schererville will not be torn up, so that traffic will meet with a minimum of inconvenience during the Winter.

Both bridges are now rapidly nearing completion, and the State has finished the 18 ft. concrete road which will connect the west end of the Ideal section with the Illinois State line. This section of paving was built to the usual State specifications, i. e., 8 ins. thick, without reinforcing.

The Ideal section paving will be 40 ft. wide on a 100 ft. right-of-way, and 10 ins. thick, 80 lbs, of reinforcing steel being imbedded in every 100 sq. ft. The State is paying, as its share of the Ideal section cost, only the amount it would pay for the usual State specifications, i. e., $33,000 per mile. The County has agreed to finance the cost of the bridge and culvert and the Lincoln Highway Association is providing the funds to meet the balance of the cost of the work, a special appropriation having been made to the Association by the United States Rubber Company for this purpose.

The beautification of the right-of-way, details of lighting and other final touches under the direction of Mr. Jens Jensen, landscape architect of Chicago, will also be accomplished next Spring, and the section is expected to be finally opened for the inspection of highway engineers and the general public early in the Spring of 1923.

Contracts Awarded

ROADS AND STREETS.

Ala., Huntsville—Williams Bros. Constr. Co., Inc., Roanoke, Va., awarded contract to grade, drain and surface 7,648 mi. Huntsville-Guntersville Rd., Madison Co., F. A. P. 39-A, gravel and penetration surfacing, at $124,056; Stanley & Singer, Lafayette, Ala., awarded contract for 6.87 mi. Decatur—Moulton Rd., Lawrence Co., F. A. P. 19-B, macadam base, penetration top; grade and drain, at $179,278. Both contracts let by State Hwy. Department at Montgomery.

Ala., Jasper—J. W. Gwinn, Birmingham, Ala., awarded contr. by State Hwy. Comn., Montgomery, for 8.99 mi. rd. in Walker Co., from Jefferson Co. line to Warrior River, at $168,851.

Ark., Osceola—Gregory & Wilson awarded contract by St. Dept. at Little Rock, for 11 mi. asph. road from Wilson to Osceola, at $400,000.

Cal., Brawley—W. F. Beal, Brawley, awarded contract for paving approx. one mile city streets, at $90,800.

Cal., Hemet—George R. Curtis, 2440 E. 26th St., Los Angeles, awarded contract for impvt. of Buena Vista St., Juanita St., Central, Acacua and other avenues, at $74,510.

Cal., Lindsay—Clark & Henery Constr. Co., 38 S. Sutter St., Stockton, awarded contract for impvt. of various streets here, at $125,412.

Cal., Newport Beach—California Constr. Co., Union Bldg., San Diego, awarded contract for paving Central Ave. and other streets, at $404,622.

Cal., Riverside—Warren Constr. Co., Oakland, awarded contract for paving road bet. Mecca and Thermal in R. I. D. No. 10, at $164,687.

Cal., Sacramento—H. H. Peterson, Loma Portal, Cal., awarded contract for paving 7.77 mi. state hwy. in Los Angeles and Orange Cos.—Long Beach to Huntington Beach, with 6-in. cement conc., at $227,394.

Cal., San Francisco—Eaton & Smith, 407 11th St., awarded contract for improving Collingwood St., 21st to 22nd Sts., at $70,000.

Cal., Santa Ana—A. R. Ford, 407 W. 17th St., Santa Ana, awarded contr. for improving portion of Bristol St., at $53,769; involving 185,332 sq. ft. 6-in. conc. paving at 22.75c ft., 3226 lin. ft. curb at 40c ft., 1546 ft. house sewers at 40c ft., 210 ft. 6-in. main sewer at 60c ft., 21 ft. 10-in. main sewer at $1 ft., 4820 ft. comb. curb and gutter at $1.95 lin. ft., 276 ft. 20-in. curb at 55c ft.

Ga., Dahlomega—T. W. Ellis, Ellis Bldg., Macon, awarded contr. for constr. of 6.8 miles rd. connecting with Cleveland-Blairsville Rd., F. A. P. 285, at $103,000; State to furnish cement.

Ky., Frankfort—Following contracts let for road work in state; Hatfield Constr. Co., road work in Carter Co., at $111,521; Ping Bros. Constr. Co., Somerset, Ky., Greensburg-Hodgensville Rd, Green Co., 5.4 mi., (conc. pipe), at $49,683; Metzel, O'Hearn, Vastine and Lewin, 12.8 mi. Barbourville-Pineville Rd., Knox and Bell Cos. (rock asph.), at $338,398; Hatfield Constr. Co., Huntington, W. Va., 9.7 mi., Morehead-Grayson Rd., Carter Co.; Haynes, Duncan & Priest, Henderson, Ky., 4.2 mi., Louisville-Paducah Rd., Daviess Co., at $21,847; Billiter & Oliver Bros., Covington, Ky., 5.1 mi. Lexington-Covington Rd., Boone Co., at $158,462; Vermilllon Contg. Co., Barbourville, Ky., 10.2 mi. Stanton-

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Compton Rd., Wolfe Co., at $81,686; Codell-Byars Constr. Co., Winchester, Ky., 8.1 mi. Stanton-Compton Rd., Powell Co., at $153,787; to same contractor, 2.1 mi. Perry Co. Hazard-Whitesburg Rd., at $87,061; Alexander Bros. 2.9 mi. Trigg Co., Cadiz-Hopkinsville Rd., at $51,329; R. B. Tyler Co., Louisville, Ky., 13.9 mi. Camp Knox-Elizabethtown Rd., Hardin Co.

Ky., Grayson—Hatfield Constr. Co., Huntington, W. Va., awarded contract by St. Hwy Comn., Frankfort, for rd. impvt. on Midland Trail, Carter Co., bet. Ashland and Lexington, at $125,000.

Ill., Waukegan—Liberty Engrg. and Constr. Co., 4238 Grand Blvd., Chicago, awarded contract for paving Sex. X-16 D, Grand Ave., from Gurney, westerly to Lake Villa Rd. (Portland cem. conc.), at $97,863.

Ind., Indianapolis—Highways Impvt. Co., South Bend, Ind., awarded contract for F. A. No. 38, Laporte Co., 5.077 miles, bit. macadam No. 1, at $109,017.

Ind., Indianapolis—Following contracts let for street and alley paving, amounting in all to $59,075; portion of Newton Ave., asph. conc. to Marion Co. Constr. Co., at $17,681; paving Spruce St., asph., to same contractor, at $9,280; Carrollton Ave., asph., to American Constr. Co., at $10,184; Linwood Ave. asph. Union Asphalt Constr. Co., $11,320; 1st alley so. of Woodlawn, W. C. Halstead, at $3,995; 1st alley w. of Illinois St., W. C. Halstead, $5,157; 1st alley no. of Ohio St., W. C. Halstead, at $1,558.

Ia., Davenport—Central Engrg. Co., 811 Putnam Bldg., awarded contr. for grading and conc. paving F. A. P. 185, River to River Rd., Type A conc., at $153,099; F. A. P. 54, Davenport-Durant Rd., Type A conc., at $155,904; Sec. B. Div. 9, F. A. P. 55 Davenport-Harrison St.—New Liberty Rd., Type A conc., etc., at $228,279; Sec. C. Div. 4, F. A. P. 55, Type A conc., etc., at $144,486; Thompson & McDanlel, Wapello, grading F. A. P. 185, $14,385.

Ia., Decorah—J. A. Dunkel, Webster City, award. contract for grading, draining etc., F. A. P., 98, Winneshiek Co. earth excav. 109,536 c. y., 27½c per c. y.; loose rock, 75c; solid rock, $1.50; J. A. Dunkel also awarded contract for P. R. P. 121, 23,798 c. y., 26c per c. y.; Louis Moe, Belmond, 12,235 ft. 6-in. tile drain, 12.4c per ft. 3 type B intakes at $18 each. 2.811 miles from Calmar toward Decorah.

Md., Baltimore—State Rds. Comn., Baltimore, let contracts for paving as follows: Contr. Cl-31, to Thomas, Bennett, & Hunter, Westminster, $84,098; Contr. BC-42 to Baltimore Asph. Blk. & Tile Co., 1320 N. Monroe St., Baltimore, $33,950; Contr. P-39 to G. B. Mullen, 1296 Upshur St., Wash., D. C., Mechanicsville, $16,037; Contr. D-28 to Holt Constr. $121,348; Contr. Sm. 21, St. Mary's Constr. Co., Co., Federalsburg, at $34,934. Bd. of Awards let contracts for grading, curbing and paving with sheet asph. 1½x1½, 1-3-6 conc. base, Lombard, Harvey, Wolfe and Ann Sts., East Ave. and Calverton Rd., to P. Flannery & Sons, Harford Rd. and 25th St., Baltimore, $74,767.

Mich., Lansing—Following state trunk line contracts awarded: Rd. 24-17 A. & B., Newaygo Co., Cl. A gravel, 16 ft. wide, 1.506 miles, to Houlding & Son, Lakeview, Mich., at $9,767; Rd. 54-6 D, Newaygo Co. Cl. A gravel, 1.504 mi. to Pierson & Allswede, Hersey, Mich., at $10,549; Rd. 3201 D, Montmorency Co., Cl. B gravel, 1.855 miles to Louks & Fenton, Whittemore, Mich., at $27,315; Rd. 11-4, D, Ottawa Co. Cl. F conc., 20 ft. wide, 0.540 mi. to Townsend-Shuttleworth-Ballmer Co., Lansing, at $10,702; Rd. 11-4, D, est. cost cement, $5,304; 39-8, Kent Co. 12 ft. culvt. to Todd & Montgomery, Sparta, at $1,962. Fed. Aid contracts let as follows: Rd. F. A. 91, Berrien Co. New Buffalo Twp. Cl. F conc., 18 ft. wide, 1.281 mi., to Municipal Contracting & Supply Co., Gary, at $25,368; F. A. 91, Berrien Co. est. cost cement, $10,642; R. 45 B-3, Ingham Co., City of Lansing, Cl. F (asph. conc.) 20 ft. in width, 0.315 mi. to County Rd. Commrs. Mason, at $10,937.

Mich., St. Ignace—Following contracts let for road work in Mackinac Co.: 1-F. A. P. 80, Secs. A & B, to S. J. Groves & Son, 120 Manhattan Bldg., Duluth, at $18,660; Newton & Garfield Twps. Grav. 12,062 miles, width 18 feet; Sec. Regan-Baker Co., Kewatin, at $113,483, Hendricks Twp., 12,366 mi., width 18 ft.

N. Mex., Roswell—New Mexico Constr. Co., Albuquerque, awarded contract for grading, curbing, guttering and paving various streets, at $170,000.

N. Mex., Santa Fe—Following projects awarded to low bidders: F. A. P. 75, McKinley Co., 26.18 mi., bet. Guam and Bluewater, to O. C. McElrath Constr. Co., Mesa, Ariz., at $137,007; F. A. P. 84, Grant Co., 21.082 mi., bet. Cliff and Mogollon, to Chas. A. Cunningham, Reserve, N. M., at $137,055; F. A. P. 90, Santa Fe Co., 4.259 mi., bet. Pankey's Gate and Canoncita, to Peterson, Shirley & Gunther, Omaha, Neb., at $47,303; F. A. P. 95, Torrance Co., 10.180 mi., bet. Willard and Lucy, to McClure & Dobson, Magdalena, New Mexico, at $44,031.

Mo., Kennett—J. W. Carmean, W. P. Robertson and B. O. Bennett awarded contract by St. Hwy. Dept. for 6.58 mi. St. rd. so. from Kennett toward Senath; conc., at $149,942.

Mo., Albany—E. L. Meek & Co., Kans. City, Mo., awarded contract by St. Hwy. Dept. for 3.680 mi. State rd. from King City to Stanberry; penetration macadam, Gentry Co. F. A. P. No. 54, at $82,691.

Mont., Missoula—H. H. Boomer, Spokane, Wash., awarded contract for Wolf Lodge-Squaw Bay road bldg. project, 4.83 miles, at $117,274. The 1,400 ft. trestle contract for Squaw Bay crossing awarded to A. B. Lefferty, Coeur d'Alene, Idaho, at $22,862.

N. Y., Mamaroneck—J. Dimando, Inc., local, awarded contract by Bd. Supvrs., Westchester Co., courthouse, White Plains, for impvt. of Mamaroneck Ave., from Washington Sq. no. to County Hwy. 1581 here ,at $90,554.

N. Y., St. George—Brooklyn & Manhattan Contg. Corp. 26 Court St., Brooklyn, awarded contract for repaving Southfield Blvd., etc., with conc., at $178,580; J. E. Donovan, 2205 Richmond Terrace, Pt. Richmond, contr. for impvt. of Washington Ave. and roadway of Henderson Terrace, Pt. Richmond, at $20,625 and $26,401, respectively.

Pa., Ebensburg—J. L. Elder, Ebensburg, awarded contract for 22.421 ft. Old Plank Rd., Cambria Twp., brick surface on conc., at $252,436.

S. C., Charleston—Simons-Wayrant Co., Charleston, awarded contract for 9.55 miles conc. highway from St. John's Isl. turn-off to Atlantic Coast Line crossing, beyond 21-mile post, St. Andrew Parish, at $283,532.

S. C., Union—Southern Paving & Contracting Co., awarded contr. to improve streets at $150,000.

Tex., Brownsville—E. P. McElwrath, Corsicana, Tex., awarded contract for paving following roads: 10.48 miles conc. rd. on State Hwy. No. 12; 10.32 miles conc. rd. on St. Hwy. No. 12, bet. Harlingen and Hidalgo Co. lines, $681,206.

Tex., Coleman—Womack Constr. Co., Sherman, awarded contract, grading and gravel surfacing 17.42 mi. St. Hwy. 7, F. A. P. 194, 16 ft., at $135,857.

Va., Newport News—Gannaway & Hudgins.

Va., Richmond—State Hwy. Dept., Richmond, let awarded contract for paving at $123,000.
contract for conc. paving 6.43 mi., Richmond-Petersburg Turnpike—Falling Creek to Dutch Gap—to C. M. Henley, 23 S. Beach St., Richmond, at $170,734; 6.27 mi. Louisa Rd., west, 22 ft., to L. R. Colbert, Richmond, at $109,590.

Va., awarded contr. for 6.01 mi., 16 ft. bitum.

Va., Richmond—Pardee-Gillespie Co., Fairfax, macadam hwy. from Chantilly to Loudon Co. line, Fairfax Co., proj. 168, Route No. 6, at $134,876.

Wash., Olympia—K. L. Golder, Ilwaco, Wash., awarded contract for 12.21 miles clearg. grading, draing. and surfacg. with crushed rock in Klickitat Co. along no. bank of Columbia River, at $334,135; Grant-Smith Co., Henry Bldg., Seattle, awarded contr. for clearg. grading and draing. 20.51 mi. Inland Empire Hwy., bet. Yakima and Umptanum, Kittitias and Yakima Cos., at $556,739. Pioneer Sand & Gravel Co., Seattle, offered best bid for placing sand and gravel along Pacific Hwy. in accord. with Hwy. Department's specifications.

Wash., Spokane—Sloan Constr. Co., city, awarded contr. for 7½ miles hard surfaced highway (Hope-Pack River section of Kootenai-Cabinet Hwy.), at $171,000.

W. Va., Welch—W. Sudduth, Bluefield, awarded contract for surfacing with rock asph. Proj. 2166, at $219,725; 5½ mi. Proj. 2168 to Albert Bros., Charlottesville, Va., at $200,400.

W. Va., Wheeling—Federal Asphalt Co. awarded contract for paving 3rd St., city, at $116,144; Fred Amrine, Brookside, awarded contract for impvt. of Sand Hill-Neff road; 8-in. sandstone base, 4 ins. slag and a thickness of Tarvia.

Wyo., Casper—Levy Construction Co., Denver, Colo., awarded contract for 18 miles road work, 9 ft. wide, 6-in. conc. base and 2-in. black top, at $516,862; Peck & Cain, Riverton and Lander, awarded contract for grading 9 miles rd. in Fremont Co., Crowheart to Circle; bridge contract (3 steel brdgs.) to J. F. Turpin, Wheatland, $59,000.

SEWERAGE AND SEWAGE TREATMENT.

Ala., Gadsden—Sullivan, Long & Haggerty, Bessemer, awarded contract for approx. 18 miles san. sewers in No. Gadsden and Oak Pk. addn., at $66,143.

Cal., Compton—Claude Fisher, 610 Wright & Callender Bldg., Los Angeles, awarded contract for constr. of sewer sys., comprising 8636 ft. 6-in., 44,969 ft. 8-in. and 981 ft. 12-in. vit. pipe sewer, including 180 manholes, house sewers, etc., at $59,378.

Cal., Delano—Constr. of sewers let to Stroud Bros., 210 Union St., Bakersfield, 1 rein. conc. settling tank, $7,000; 2 sludge beds with roadways, 200 ft. drain, $252; 3,978 lin. ft. 24-in. conc. pipe sewers, $2.34; 434 lin. ft. 18-in., $1.86; 18,227 lin. ft. 16-in., $1.44; 9131 lin. ft. 12-in., $1,245; 9,961 lin. ft. 10 in., $1,085; 38,776 lin. ft. 8-in., $0.92, etc. Total, $119,000.

Cal., Glendale—Cox & Teget, 222 Harvard Pl., Ontario, awarded contract for constr. of Verdugo Canyon sewer laterals, at $45,399.

Colo., Denver—J. E. Young, 1267 S. Race St., awarded contract for Washington Park storm sewer dist. 169.78 in. and segment blk., 27-66 in. brk, and 10-24 in. conc. pipe, at $334,107.

Ind., Indianapolis—Following sewer contracts let: Warman Ave., sewer to Columbia Constr. Co., at $9,496; Drexel St., same contractor, at $8,094; Mount St., to same contractor at $3,501; Sheffield Ave. sewer to Sheehan Constr. Co., at $8,816.

Kans., Kansas City—T. M. Torson Constr. Co., 73rd St. and Metropolitan tracks, awarded contract for 2 mi. storm sewers for Armourdale, 6 ft. diam., flood gate and force pump; engineer's est., $145,000.

Kans., Wichita—A. A. Dobson, 802 1st Natl. Bldg., Lincoln, Neb., awarded contract for excav. and laying sewer pipe in segmental blk., at $190,168.

Mich., Detroit—J. Wagner, 2736 W. Grand Blvd., Ryan Ave., arm ser., mile road sewer, $48,602; R. D. Baker, 1631 Elmhurst Ave., Fenelon Ave., arm of 7-mile rd. sewer, $37,286; Connelly Bros., 2269 Hamilton Ave, Edison Ave., arm, at $68,260; Westminster Ave., arm Bates St. sewer, $49,690; C. R. Lennane Co., 2631 Woodward Ave., Huston Ave., arm of Gratiot Ave., sewer, at $41,264.

Mich., Lincoln Park—(Wyandotte P. O.)—Callahan & Grosse, Lincoln Park, awarded contract for 8,030 ft. 8-48 in. vit. crock sewer in Emmonds Blvd., at $38,192.

Mich., Springwells—Contr. for bldg. 3447 ft. Sec. 10, main trunk sewer, to Detroit Draing. Constr. Co., 5099 Lemay Ave., Detroit, at $65,678; 5088 ft. Sec. 14, main trunk sewer, to J. Porath, 745 Grlswold St., Detroit, $103,677; grading Schaffer Rd. to Closser Bros., 8427 Stencfor Ave., Detroit, at $14,059.

Minn., Eveleth—Laurence McCann Co., Eveleth, awarded contract for sewer disposal plant, etc., at $75,000.

Mo., Cape Girardeau—J. J. Dunnegan, Shenandoah, Ia., awarded contract for contstr. of sewer system; 16 miles of sewers from 8-in. to 102-in. in diam., at cost of $352,000.

N C., High Point—H. D. Berry, Bessemer, Ala., awarded contract for sewerage work at approx. $76,000.

N. Y., New York—Spadaro Contg. Co., 827 E. 217th St., awarded contr. for sewer in Webster Ave. at $518,984; paving with sheet asph. W. 190th St., etc., to C. D. Beckwtih, 2875 Broadway, at $7,979.

Ohio, Marion—A. Bentley & Son Co., 201-31 Belmont Ave., Toledo, awarded contract for sewage plant at $436,000; Kohlbarger & Hoyles, Marion, contract for sewerage system at $16,316.

Ohio, Marion—Kobarger & Noyles, Marion, awarded contract for construction of trunk line sewer at $78,809.

N. C., Taylorsville—Electrical Constructors Co., 508 W. 4th St., Charlotte, awarded contract for constr. of sewerage and water works systems at $63,418.

N. H., Manchester—T. Stuart & Sons Co., 222 Pearl St., Newton, awarded contract for rein. monolithic culvert outfall sewer, all connections, at $189,000.

Ohio, Cleveland—Contracts for sewers in Carnegie Ave. to D. Zullo, 10601 Hudson Ave., at $10,671; Aspinwall Ave. and Saranac Rd., also Pearl Rd., relief sewer to Manson Co., 335 The Arcade, $27,967 and $68,042, respectively; Roseland Ave. to Hadded-Hall Co., Schofield Bldg., at $16,720.

Ohio, Columbus—Following contracts let: Vit. sewer in sewer dist., Clinton 2, Contr. 13, to Gangl Constr. Co., 737 2nd Natl. Bldg., Akron, $66,929; Sewer Dist. Clinton 2, Contr. 12, to C. F. Smith, 64 Davies St., Dayton, $12,163; vit. or conc. sewer in Sewer Dist., Marion 1, to W. Nellson, 1616 Summit St., at $18,721.

Okla., Paul's Valley—V. V. Long & Co., Okla. City, Engrs., preparing plans for storm sewers and paving to cost $50,000 to $100,000.

Pa., Altoona—Bell Bockel Co., Inc., Central Trust Bldg., awarded contract for 14,00 ft. terra cotta and concrete sewer pipe, etc., at $61,149.

Pa., Philadelphia—Jackson & Co., 119 S. 4th St., awarded contract for sewage disposal plant, 40th Ward, at $153,900; mechanical equipt. to Sanitary Corp., 165 Bway., New York City, at $49,000.

Pa., Pittsburgh—Following sewer contracts let: Edgerton Ave., John E. Born, at $2,589; Bernard St. Frank, Mannella, $2,364; Wightman St., F. Mannella, $2,179; .Shady Ave., Mannella Bros., $2,510; Orchlee Ave., F. Mannella, $4,329.

Tex., Fort Worth—McKenzie Constr. Co., San Antonio, awarded contract for constr. of sewage disposal plant on Trinity River, at $699,990.

Wis., Ellsworth—Camden Constr. Co. (J. B. Camden), Benson, Minn., awarded contract for pipe sewers at $30,732; W. C. Ottman and F. H. Johnson, Ellsworth, contract for disposal tanks Nos. 2, 3 and 4, at $8,961, $4,933 and $3,048.

WATER SUPPLY AND PURIFICATION.

Cal., Santa Barbara—U. S. Cast Iron Pipe & Foundry Co. awarded contract for furnishing water pipe at about $50,000.

Ont., Alvinston—Goldie & McCulloch, Galt, awarded contract for installing new electrically operated water works pumps; engr.'s est., $260,000.

Quebec, Montreal—Laurin & Leitch Eng. & Constr. Co., 690 Union Ave., awarded contract for 11,000 ft. 40-in. steel force mains from pump. sta. to Atwater and Sherbrooke Sts., and 2,000 ft. 30-in. steel force main in Sherbrooke St. from Atwater to Oliver Sts., at $600,000.

Ont., Port Credit—Turbine Equipment Co., 73 King St., W. Toronto, awarded contract for pumping equipt. for pump house; hydrants to Dominion Steel Products Co., Brantford, Engrs. Ttotal est., $45,000.

Fla., Haines City—J. B. McCrary Co., 3rd Natl. Bank Bldg., Atlanta, awarded contract for water works and san. sewerage systems, at $60,600.

Kans., Morrill—Hybskman & Wiley, Seneca, awarded contracts for water works and sewerage systems at $22,770 and $21,829, respectively.

Ill., Jerseyville—C. M. Hanes, Jerseyville, awarded contract for 34,320 ft. 10-in. mains, 1 sty. 26x36 ft. stone pump house, rein. conc. reservoir, 1,000,000 gal. capy., pumps, etc., at $215,740.

La., Alexandria—A. M. Lockett Co., New Orleans, awarded contract for steel pipe; Standard Sanitary Mfg. Co., New Orleans, contract for valves, jute and lead wool; U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J., cast iron pipe. Will call new bids for laying mains. Cost, together with gas distribution plant, $360,000.

Minn., St. Paul—St. Paul Water Dept. will do following work by day labor. Construct high serv., rein. conc. reservoir for new water works plant, 18,000,000 gal, capy.; inside dimensions, 306x414 ft., 20 ft. deep, groined arch flr. and flat slab roof, rein. conc. retaining walls, 14,000 c. y conc. and 600 tons steel. Est. cost, $200,000. J. W. Kelsey, Supt. Water Dept.

Neb., Omaha—Worthington Pump & Machy. Corp., 37 W. VanBuren St., Chicago, awarded contract for 50,000,000 gal. pump for Florence Water Sta., at $40,600.

N. C., Greensboro—Pittsburgh-Des Moines Steel Co., Southern office, Richmond, Va., awarded contract for constr. of filtration plant at $107,015.

Ohio, Cleveland—T. P. Egan, Caxton Bldg.,

awarded contract for 18,460 lin. ft. cast iron mains in impvt. 16 of Cuyahoga Co. Water Dist. at Parma, at $78,853.

Ohio, Sebring—E. J. Landor, Renkert Bldg., Canton, awarded contract for water purification plant at $41,270.

Ohio, Steubenville—Federal Asph. Co., Hamilton, awarded contract for furnishing 127 tons Cl. C cast iron pipe, f. o. b. Steubenville, at $116,145.

Okla., Tulsa—Following contracts totaling $5,492,322 let by Water Commrs. for spavinaw water enterprise: No. 1, constr. of 60 miles telephone line, Tulsa to Spavinaw, at $11,606, to Vinita Elec. Co.; 2 Clearg. site Spavinaw Lake, at $20,250 to Standard Paving Co., Tulsa; 3 Spavinaw Dam, at $787,610 to Standard Paving Co., Tulsa; 4, constr. of 60-in. pipe line from dam to tunnel at $2,136,980 to Wallbridge-Aldinger Co., Detroit, Mich.; 5, constr. of tunnel at $304,057 to Standard Paving Co., Tulsa; 6, constr. of 54-in. pipe line from tunnel to Mohawk Reservoir, at $1,715,160 to Wallbridge-Aldinger Co., Detroit; 7, constr. of Mohawk Reservoir, 500,000 gal. capy., at $105,956, to R. M. Davies & Sons, Tulsa; 8, furnishing 36-in. cast iron pipe, $210,792, to U. S. Cast Iron Pipe & Foundry Co., Burlington, N. J.; 10, laying c. i. pipe from high pressure reservoir to city, at $49,358, to Standard Paving Co., Tulsa; 11, high pressure reservoir, no. of city, at $150,553, to Traylor-Dewey Contg. Co., Allentown, Pa.; Trammell & Holway, Engrs., 1446 Monadnock Bldg., Chicago.

S. D., Rapid City—Plans prepared for constr. of municipal water works system, $175,000, bonds issued.

Tenn., Memphis—D. D. Thomas & Son awarded contract for constr. of reservoir and sub-struct. of water plant at $527,000. Will open bids in November for constr. of superstructure.

Utah, Ogden—F. W. Spencer Co., State St., Salt Lake City, awarded contract for furnishing and laying 550 tons cast iron pipe, valves, etc., at $49,202.

W. Va., Parkersburg—Chamber of Com. interested in impvts. to water supply. Est. cost about $150,000. Layne & Bowler, Engr., Cincinnati.

Prospective Work

ROADS AND STREETS.

Ala., Dothan—Bureau of Public Rds., Montgomery, Ala., contemplates bldg. 21.55 mi. Bee Line Hwy., Houston Co., from Dale Co. line to Florida line through County.

Ala., Oneonta—Blount Co. plans to construct 16 mi. rd. bet. Village Springs and Oneonta; bids in about 30 days.

Ark., Pine Bluff—Good Roads Comm., Chamber of Commerce, W. J. Parkes, Chrmn., has tentative plans for rebldg. 100 miles main highways leading out of Pine Bluff, including Dollarway from Pine Bluff to Pulaski Co. line, and Tampo Pike from Pine Bluff to jct. with Ark.-La. highway. Est. cost, $2,000,000.

Cal., Fresno—City Engr., Wm. Stranahan, has completed plans for impvt. of Welden Ave. bet. VanNess Ave. and east city limits, involving 75,830 sq. ft. grading, 58,165 sq. ft. asph. paving, 5,250 sq. ft. conc. gutter, 6,630 sq. ft. conc. walk, 1,340 ft. curb, 272 ft. 12-in. culvert, 44 ft. 18-in. culvert, 7 manholes.

Cal., Santa Monica—Commr. Wm. H. Carter states that city contemplates expending over $1,100,000, exclusive of proposed $1,200,000 bond issue, to open Trolleyway, Main and other streets.

Fla., Jacksonville—Duval Co. Commrs. plans improving following: 10.38 mi. rd. from end of present perm. hwy. on King's Rd. to County line through Dinsmore; 12.83 mi. rd. from end of present perm. hwy. to Nassau River toward Yulee; 8.25 mi. rd. from city limits to Co. line through Ortega; 20.02 mi. rd. from S. Jacksonville city limits to Co. line through Hollywood, connecting with St. Augustine rd. through Bayard; 8 miles rd. from Baldwin to Co. line through Maxville; two one-way roads on Beach road, utilizing present Beach rd. for one, and So. Jacksonville to Pottsburg Crk. right-of-way for other; 15 miles hard surf. rd. from Neptune to Pablo Beach and from Neptune to Atlantic Beach. C. S. Coe, Co. Engr.

Fla., Plant—City considering paving Baker St. Voted Oct. 31 on $55,000 bonds; construct storm sewers. Voted Oct. 31 on $10,000 bonds.

Fla., Sebring—Highlands County having preliminplans prepared for surfacing 5 or 6-in. rock on 5-mile rd. from Sebring via O'Berry's to Hardee Co. line, $25,000; surfacing with conglomerate material to be dredged from canal, 18-in. thick; 23-mile rd. from Lake Annie to Kissimmee River, $200,000; grading and claying with probably 5 to 10-mile fill; 30-mile rd. from DeSoto City or Sebring to Bassenger; 5-in. compacted rock base and probably asph. surf.; 45-mile rd. from Polk Co. to Glades Co. via Avon Park, Sebring, Venus, etc., $300,000. W. C. Peacock, Sebring, Engr.

Fla., W. Palm Beach—Palm Beach Co. Commrs., H. Harris, Chrmn., considering impvt. of following roads: 17 miles from Belle Glade to Lee Co. line, $221,000; 20½ mi. from bend in W. Palm Beach Canal to Canal Point, $225,000; 1½ mi. from Gladcrest to cross state hwy., $16,500; 8½ mi. from Kramer Island to Belle Glade, $126,000; 8½ mi. from Pahokee to Kramer Island, $127,000; 2½ mi. Bacom's Pt. to connection with Pahokee Rd., $35,000; 6¼ mi. from Gardenia to connection with cross-state rd. on bank of Miami Canal, $71,500; 9 mi. from Okeelante to Gladcrest, $78,000; Military Trail, Lake Worth Rd. and brdg. over W. Palm Beach canal, $35,000.

Ga., Brunswick—St. Simons Hwy. Dept., showing approx. cost of constr. of highway to St. Simons from Brunswick. Est. cost, $300,000.

Ill., Springfield—Mr. Clifford Older, Chief Hwy. Engr., states that Hwy. Dept. is ready to complete plans and surveys on DePue-Spring Valley section, and also on Princeton-DePue section of the Ivy Way hard road, Bureau County.

Ind., Indianapolis—State Hwy. Dept. plans to hard surface 11.2 mi. State Rd. 6, Marion Co.; 8 mi. St. Rd. 10, and 7 mi. St. Rd. 4, Vanderburg Co.; 11.5 mi. St. Rd. 1 St. Joseph Co.; 26 mi. St. Rd. 1, Jackson Co.; 12 mi. St. Rd. 2, Allen Co.; 24 mi. St. Rd. 1, Hamilton Co. All 16-ft. C. Gray, State Engr.

Ky., Frankfort—McCreary County has offered to put up $200,000 of recent bond issue for work on Dixie Air Line in County. Commission has accepted offer.

La., Bastrop—Morehouse Parish Police Jury contemplates bldg. 143 miles of roads. Vote Dec. 16 on $1,150,000 bonds. Rd. Dist. No. 1 on $329,700; Rd. Dist. No. 2, on $820,300.

La., Jennings—City will pave and gravel certain streets; $135,000 bonds voted.

La., Lake Charles—City considering public utilities and public impvts. to cost $2,000,000. J. A. Trotti, Mayor. Impvts. will consist of street paving, increased water supply and impvts. to traffic conditions.

La., Leesville—Vernon Parish Police Jury will improve rds. in Dist. No. 6; $370,000 bonds voted.

La., New Orleans—City considering $3,227,352 expenditure for street paving, including Apple, Audubon, Baldwin, Burthie, Bayou, Cadiz, Carrolton, Carondelet, Constance, Dauphine, Dufossat, Eleonore, Fontainbleau Drive, Governor, Nicholls, etc., etc.

Michigan—Emmett County plans to construct 38½ miles gravel road in 1923, also several miles conc. pavement on main trunk lines by county and state. Gravel rd. will be 10 mi. on Center pike, 2 mi. no. of Pellston, w. 6½ mi. on Pleasant View pike, no. from nr. Sexton's cors. and 22 mi. on Shore Drive to Cross Village. Conc. pavement will be on so. entrance to city leading to Mitchell St. and w. leading down Charlevoix Ave., Jackson to Mitchell. Mile conc. pavement through Allanson will be built and rd. through Harbor Springs completed. Mr. Tripp, Engr., Oakland County, will get 16 mi. new conc rd. in 1923 if plans of State Hwy. Dept. are carried out, as announced by L. V. Belknap, Oakland Co. Hwy. Engr. Extensive rd. bldg. program will be carried out in Monroe Co. if State Legislature will authorize sale of $10,000,000 worth of rd. bonds, in which County will share. Tentative program includes constr. new Dixie Hwy. bet. Monroe and Stony Crk., 1.5 mi. long and 20 ft. wide; F. A. P. No. 73 and new section Ida-Bedford Rd., in Monroetown, LaSalle, Erie and Bedford Twps.; F. A. P. 42, 14.5 mi. (gradg. brdgs. and culverts) cost $100,000. New sect. Ida-Bedford

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Bruces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Rd. will cost $150,000 and run from Samadia to state line, 5 miles. 16 miles Chicago turnpike and grading and draing. of eastern 15 mi. is contemplated by State Hwy. Dept., Lansing. State also planning to build 2 mi. ont runk line No. 80, bet. Adrian and Rome Center.

Mass., Boston—State Hwy. Dept. contemplates paving 5700 ft. rd., 18-ft. from Ware to Enfield, Hampden Co., 34,200 sq. yds. conc. $75,000 State Bd. Pub. Works, State House, Boston, Engrs.

Miss., Mayersville—Issaquena Co. contemplates constructing greater part of Mississippi River Scenic Hwy., no. of Warren Co.; $230,000 bonds voted.

Miss., Senatobia—Tate County Supervisors plan constr. of 12 miles of Jefferson Davis Hwy. through County. Est. cost $100,000. Will request $80,000 Federal aid.

N. Y., Bath—Steuben Co. plans paving 4 miles Hornell-Loon Lake Rd., $155,000; 5.25 mi. Hammondsport-Branchport Rd., $308,209; 4.5 mi. Lawrenceville Rd., $231,500, asph. conc. or brick. Engineer not announced.

N. C., Hillsboro—T. M. Arrasmith, Mayor, will pave 1 mile of street concrete with sheet asph. finish; $60,000 bonds voted for impvt.

N. C., Wilmington—Commr. of Pub. Wks. R. C. Cantwell contemplates 80,000 yds. street paving, asph. and brick, $200,000. Carolina Engrg. Co., Engr,. Wilmington.

Ohio, Dayton—Montgomery County considering paving 4 miles Dayton-Greenville Pike; also 4 miles Germantown-Middletown Pike, 18-20 ft., 90,000 sq. yds. conc or brick; $160,000. W. O. Pease, Co. Surv.

Pa., Clarion—Commrs. of Clarion Co. and others considering improvement of road from Venus to Fryburg at cost of $100,000. New Castle plans to widen Mercer, Mill, North and Neshannock streets from 60 to 75 ft. at cost of $25,000.

S. C., Spartansburg—State Hwy. Comn., Columbia, considering constr. of 2 miles hard surf rd. from Arkwright. Est. cost, $70,000.

Tenn., Jonesboro—City and Washington County contemplates following improvements: Repairing 10 or 12 roads in County; macadamizing road from Johnson City to King Springs; placing tile under Adams fill on Blountsville road.

Tenn., Manchester—Coffee Co. preparing plans for constr. of macadam road system; $400,000. N. H. Meriwether, Co. Engr.

Tex., Angleton—Brazoria Co. considering constr. of St. Hwy. 19 through Rd. Dist. 16; St. Hwy. Comn. granted $130,000 aid. C. D. Jessup. Co. Judge.

Tex., Edinburg—Hidalgo Co. plans bldg. 14 miles of road on St. Hwy. No. 12, connecting Brownsville with San Antonio on north and with Houston on east; concrete or asph. surfacing; $600,000. Proj. 301.

Tex., Houston—Harris County Commrs. court plans following: Type B Rds, 3 mi. Katy Rd; 10 mi. Washington Co. Rd.; 10 mi. Spring Rd.; 3 mi. Goose Creek-Cedar Bayou Rd.; 3 mi. Telephone Rd.; 2 mi. Almeda Rd.; 4 mi. Bellaire Blvd.; 2 mi. Westheimer Rd. Awards contingent on passage of $6,000,000 bonds.

Tex., Lufkin—Angelina Co. plans bldg. 13.54 miles 16-ft. gravel rd. bet. Huntington and Zavella, $181,500. John Roberson, Co. Judge; G. R. Abney, Co. Engr. Will receive bids soon.

Texas, McKinney—Collin Co. Commrs. will hard surface 2.16 miles State Hwy. No. 1; $450,000 bonds voted. F. W. Cawthorn, Co. Engr.

Texas, Pearsall—State Hwy. Dept., Austin, has approved plans for 17.2 miles Meridian Hwy., Frio Co.; Pearsall to Medina Co. line; gravel surfacing, bitum. topping, $283,270. J. C. Pranglin, Co. Judge. J. D. Metcalfe, Co. Engr.

Va., Fairfax—State Hwy. Dept., Richmond, Va., will construct 8-mile Lee Hwy. from Broad to Washington Sts., Falls Ch. to Fairfax Courthouse, Fairfax Co., Falls Ch. and Providence Dists. Will vote in November on $275,000 bonds.

Wash., Seattle—Plans completed by King Co. Engr., Thomas R. Beeman, for filling, grading and graveling 2 mi. East Valley road from Auburn so. to Pierce Co. line. As soon as right-of-way releases have been obtained, probably within next 30 days, bids will be asked. Quantities involved in impvt. include 37,812 cu. yds., borrow excav. 7,888 c. y.; 366 ft. 12-in. vit. or conc. pipe; 60 ft. 18-in. pipe; 54 ft. 24-in. and 54 ft. 30-in. pipe.

W. Va., Buckhannon—Upshur County plans to improve roads: Moade Dist., $81,000; Banks Dist., $17,000; Union Dist., $120,000; Warren Dist., $95,000. State Rd Comn. will give 50 per cent aid. Vote in November on bonds.

W. Va., Weston—Lewis Co. Commrs. Court, Freeman's Crk. Dist., plans bldg. hard surf. roads. Will vote on $800,000 bonds.

SEWERAGE AND SEWAGE TREATMENT.

Ont., Sandwich—City plans to extend sewerage system at cost of $25,000. E. R. North, City Engr.

Cal., Los Angeles—City Engr. J. A. Griffin has been ordered by Bd. Pub. Wks. to prepare plans and specs. for 1st 3 units of new $12,000,000 sewage dis; wks. Est. cost of bldg. treat. plant, incinerator, 1-mi. exten, sewer oceanward and incidental items, is $1,450,350.

Ct., Hartford—City plans to extend interceptor sewerage system in Blue Hills Ave. at cost of $34,000. City Engrg. Dept., care Public Works Board, Engrs.

Ill., Astoria—Town making plans for 4 miles sani. sewerage system, including disposal plant, 60,000 gal. settling tank, centrif. pump, 18,480 ft. 8-in. and 2,640 ft. 6-in. vit. clay pipe, 17,000 c. y. excav., etc.; $40,000. W. A. Fuller Co., 1917 Ry. Exh. Bldg., St. Louis, Mo., Cons. Engrs.

Ill., Brookfield—Will advertise for bids about Dec. 1st for mains. Est. cost, $55,000. E. Hancock, 2047 Ogden Ave., Chicago, Engr.

Ill., Elmhurst—Will take bids about Feb. 1st for sewerage system and disposal plant. Cost, $150,000. E. Hancock, Chicago, Ill., Engr.

Iowa, Cascade—Prelim. steps being taken for establishment of sewerage system at approx. $75,000. Survey of town recently made.

Ia., Muscatine—State Engr. has approved plans for sewerage and drain. project in So. Muscatine. Approx. cost to impvts. $100,000.

Ky., Louisville—Construction program, including installation of several sidewalks, sewers and streets in various sections of city, costing $160,000, authorized by lower board of General Council.

Mich., Detroit—City having plans prepared for 1½ miles storm sewer in Bedford Rd., 9 ft. 6-in. diam., 3 ring brk. or monolithic concrete. J. W. Reid, City Engr.

Mich., Grand Rapids—Milton P. Adams, City San. Engr., has completed plans for new sewage disposal plant here. Will submit plan to City Comn. in near future. City Maiager, Fred H. Locke.

Md., Brunswick—City voted $30,000 sewer and street bonds.

Mich., Grosse Pointe—(Detroit, P. O.)—City considering 3,500 vit. crock or segment blk. sewer in Kerby Rd.—Ridge Rd. to Black Marsh Crk.—including 1,750 ft. 36-in., 940 ft. 24-in. and 810 ft. 22-in. pipe. $25,000. R. H. Erly, Engr.

Mich., Royal Oak—(Detroit, P. O.)—Plans being prepared for 17,600 ft. main trunk sewer, including 610 lin. ft. 18-in., 2,250 ft. 15-in., 4,332 12-in., 5,620 ft. 10-in., 2,176 ft. 8-in. and 1,420 ft. 6-in. vit. crock pipe. Hoad, Decken, Shoecraft & Drury, Ann Arbor, Cons. Engrs.

Miss., Corinth—City will soon take bids for 29,000 ft. 8-10 in. vit. pipe sewer in various streets, 85 brick manholes with c. i. frames and covers, 10 tons c. i. pipe with sewer crossing streams, 6,200 cu. yds. earth trenching. $35,000. A. H. Beard, 616 Title Guaranty Bldg., St. Louis, Mo., Cons. Engr.

Mo., St. Joseph—It is proposed to extend Blacksnake sewer 12 ft. in diam. and as cost of $86,000.

Mo., St. Louis—City has under consideration plans for expend'g. $11,000,000 for conversion of River des Pres into closed sewer; also for expending $8,000,000 for following work: Exten. Baden sewer, $450,000; exten. of Wherry Ave. outlet sewer, $160,000; Mill Crk. relief sewer, $2,750,000; Rock Branch, Western exten., $550,000; southern Arsenal relief sewer, $1,100,000; Ferry St. relief sewer, $100,000; reconstr. of 11 outlets to Mississippi River, $300,000; additional street inlets, $150,000. W. W. Horner, Chf. Engr. Sewers & Paving.

N. Y., Dundee—Village plans construction of sewer system at estimated cost of $70,000.

N. Y., Rochester—City contemplates storm, water and outlet sewer in Meriden St. and other thoroughfares. Est. cost, $60,000. C. A. Poole, City Engr.

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric .
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
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Pipe Dip and Coatings.
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Portable Stone Bins.
Austin-Western Road Machinery Co.
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Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

O., Cleveland—City plans storm relief sewer in E. 65th St.—Euclid to Central Aves. $125,000. R. Hoffman, City Hall, Engr.

O., Cleveland—S. H. Gleinman Realty Co. will soon take bids for storm and san. sewers in Elmwood Park allotment. $40,000. Lander Engrg. Co., Blackstone Bldg., Engrs.

O., Cuyahoga Falls—Plans being made by City Engr. here for entirely new storm water sys. throughout city.

O., Euclid—City considering bldg. sewage disposal plant at cost of $250,000. F. A. Pease Eng. Co., Marshall Bldg., Cleveland, Engrs.

Pa., Carbondale—City contemplates laying surf. sewers on Main St. at cost of $7,000; Maple Ave., $1,370; Copeland Ave., $2,450; Dundaff St., $9,850; Chestnut Ave., $785; 8th Ave., $11,650; Salem Pk., $3,850; Laurel St., $7,900. W. L. Giles, City Engr.

Pa., Scranton—San. sewerage system planned here. Est. cost, $52,763. W. P. Huester, Clk.

S. D., Leola—City will ask bids this winter for sewer system and disposal plant. Engrs. Cory & LeCocq, Aberdeen. Start work in sprinf, $20,000.

Wash., Kelso—Long-Bell Lumber Co., 14th and Kenman Sts., Kans. City, Mo. contemplate constr. of storm and san. sewerage systems; 2 miles 48-in. cast iron pipe. Private plans.

Wis., Birnamwood—Plans being prepared for storm and san. sewers at cost of $25,000. W. G. Girchoffer, Dean Blk., Madison, Engr.

Wis., Eagle River—Plans prepared for san. and storm sewers; also disposal tank. $25,000. W. G. Kirchoffer, Dean Blk., Madison, Engr.

Wis., So. Beloit—(Beloit, P. O.)—Bd. Local Impvts., will soon receive bids for outfall sewer bulkhead, etc., in San Dist. 1, 2½, 3½ and 4-ft. rein. conc. pipe. $78,000. L. A. Parsons, Pres.; R. Butterman, Goodwin Blk., Beloit, Wis., Engr.; G. L. Claussen, 139 N. Clark St., Chicago, Cons. Engr.

Wis., LaCrosse—City considering constr. of trunk sewer extension in 16th St. $50,000. C. Congdon, City Hall, Actg. City Engr.

Wis., West Milwaukee—City preparing plans for bldg. san. sewers in various streets. $30,000 bonds issued. Parsons and Orbert, 216 W. Water St., Milwaukee, Cons. Engrs.

WATER SUPPLY AND PURIFICATION.

Ark., Piggott—$600,000 will be expended by City for constr. of water works system.

Ariz., Flagstaff—Plans being made for new water supply system, including reservoir of 100,000,000-gal. capy. Est. cost, $500,000. Burns & McDonnell, Interstate Bldg., Kans. City, Mo., Engrs.

Cal., Eagle Rock—A $48,000 bond issue will be submitted soon to install new 4-in. water mains, 123 fire hydrants; also $60,000 for sinking 2 more wells, constructing large reservoir on Sagamore Hill and laying 12-in. main in Colorado Blvd. and one in alley west of Central.

Cal., E. San Diego—Election Oct. 30th to vote on $31,000 bond issue for purchase of Fairmount water system which will be remodeled into a municipal system. Cuyamaca Water Co., will construct entirely new pipe line on El Cajon Blvd., bet. Euclid and Van Dyke Aves. Work will start within 90 days. Pipe will be 14-in. steel guaranteed for 15 yrs.

Cal., Inglewood—Voters have authorized bond issue of $57,500 for purchase of water-bearing land and $157,000 for new water equipment and extensions of lines.

Cal., Lakeport—City will construct $75,000 water and sewer systems.

Cal., Orange—Survey of proposed Santigo canyon reservoir proj., under consideration for some time, has been ordered by the Irvine Company and Carpenter and Serrano water companies. Plan calls for reservoir capable of 1,500-in. flow during 200 days. Expense will be borne half by Irvine Company and half by water companies.

Cal., Santa Monica—Commr. Wm. H. Carter announces that $50,000 will be expended on impvts. to water sys., an increase of over 9,000 in population making certain changes necessary.

Ont., Wheatley—Plans being prepared for new water works system. Est. cost, $30,000. Prices desired on all equipment. R. O. Wynne-Roberts, 40 Jarvis St., Toronto, Cons. Engrs.

Ont., Whitby—Plans drawn for slow sand filter and 1,000 ft. extension to cost $54,000. F. W. Thorold, Engr., 54 Admiral Rd., Toronto.

Ont., Windsor—Plans being prepared for filtration plant here. Est. cost, $125,000. James, Proctor & Redfern, Excelsior Life Bldg., Toronto, Engrs.

Fla., Pensacola—City will advertise for bids in near future for extens. and impvts. to water works system. Approximate cost, $220,000. F. D. Sanders, Commr.

Ill., Astoria—Plans being made for water works, including 30,000 gal. impounding reservoir, 200,000-gal. a day rapid sand filter plant, 4 motor driven centrif. pumpg. units, filter plant, pump house, 13,200 ft. 6-in. cast iron mains, etc. $40,000. W. A. Fuller Co., 1917 Railway Exch., St. Louis, Mo. Engrs.

Ind., Bloomington—City Council voted in favor of employing expert hydraulic engineers, and to construct new water sys., either in Griffy Creek or White river valley. Between one and two million dollars may be expended on new water works. Councilmen Lewis, Franklin, Pittinger and Wells appointed to employ engineer.

Ind., Laporte—State Bd. has approved issuance of $100,000 water works bonds for constr. of additional mains.

Ind., Upland—Upland Water Co. plans construction of new electrically equipped water plant. Est. cost $45,000.

La., Plaquemine—City will construct water and light plant.

Mich., Clawson—Plans being completed for water works system: 11,150 ft. 8-in. and 200 ft. 6-in. cast iron mains, 17 fire hydrants, 15 8-in. gate valves, 17 6-in. gate valves with boxes, spcls., 75,000 gal. elevated steel water tank, etc. Ruhling, Holdsworth & Hudson, 16549 Woodward Ave., Highland Park (Detroit, P. O.), Engrs.

Mo., Kansas City—Fuller & McClintock, Cons. Engrs., have outlined impvts. planned for water works system within next six years as follows: Additional high lift pumping capy., requiring constr. of East Bottoms pumping sta. and equalizing reservoir; pressure tunnels betw. Turkey Creek and East Bottoms stations, and at least one discharge main from East Bottom Sta., right-of-way for main tunnel from Platte Clay Co., site to city, etc.

N. C., Davidson—City will construct water works, sewer system and electric light plant. $30,000 sewer bonds voted and $60,000 light and water bonds.

N. Y., Dundee—City considering bond issue in amt. of $125,000 for constr. of water works system.

Okla., Skiatook—City will extend water and sewer systems; voted $44,000 bonds.

Okla., Tyrone—Town Board will soon receive bids for water wks. system, including power house. $70,000. H. Knott, City Engr.

Ore., Portland—Measure authorizing $500,000 bond issue to provide high-pressure water for fire fighting in business dist., may go on ballot at Nov. elec. Proposal now being considered by committee composed of Fire Chf. Young, F. Randlett, Chf. Engr. Water Bureau and O. Laurgaard, City Engr.

Tenn., Memphis—City will issue $1,200,000 water bonds; $1,322,000 street bonds; $100,000 sewer bonds; $252,000 terminal and warehouse bonds.

Tex., Beaumont—City has $350,000 available for impvts. and extensions to water works system.

Tex., Greenville—City considering enlarging water supply. Will vote on $100,000 bonds. A. D. Duck, City Engr.

Tex, Kosse—F. R. Young of Young & Young, Archts., Dallas, interested in organization of company to develop water supply system on Rocky Creek; establish reservoir with storage capy. of 22,200,000 bbls.; construct temp. dam now, later construct perm. dam 300 yds lower down, space bet. the two dams to be used for reserve supply of water.

Tex., Teague—Extensive water works impvts. planned here. J. B. Hawley, Dallas, Cons. Engineer.

Wn., Camas—Plans being prepared for water works impvts., including 7 miles wood pipe. $40,000 Stevens and Koon, Spalding Bldg., Portland, Ore., Engrs.

W. Va., Bluefield—Bluefield Water Wks. Impvt. Co., having plans prepared for mechanical water filters, 2,000,000-gal. capy. Alvord, Burdick & Howson, Engrs., 8 S. Dearborn St., Chicago, Cons. Engrs.

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Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
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Road Planer.
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Road Oil and Preservatives.
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Standard Oil Co. (Indiana)
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Road Rollers.
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Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
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Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
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Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
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Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

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Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
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Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

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Austin Machinery Corp.
The Hug Co.

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Austin-Western Road Machinery Co., The

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Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
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Pawling & Harnischfeger.

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De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

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Cannelton Sewer Pipe Co.

Warrenite.
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U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
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The Flower Company.
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Murphysboro Paving Brick Co.
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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
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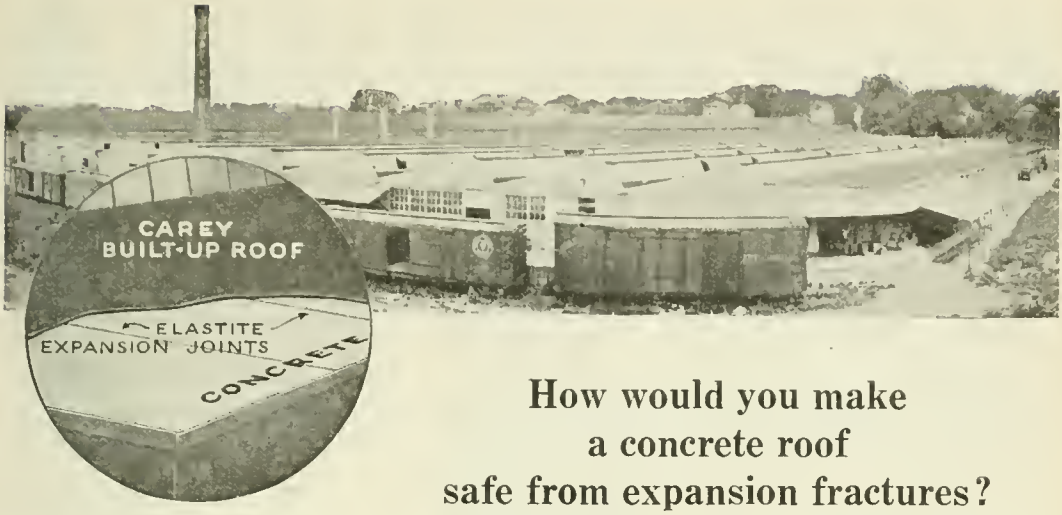

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In midsummer the temperature on this roof is as high as 110 degrees. In winter it drops to 10 degrees below. But the Elastite never melts in the heat nor loses its elasticity in low temperature. The melting point of Elastite is 250 degrees Fahrenheit. It is still elastic at 32 degrees Fahrenheit.

Elastite makes concrete construction for roofs, streets, bridges and other structures safe from injuries by expansion and contraction.

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10-22

Carey Elastite

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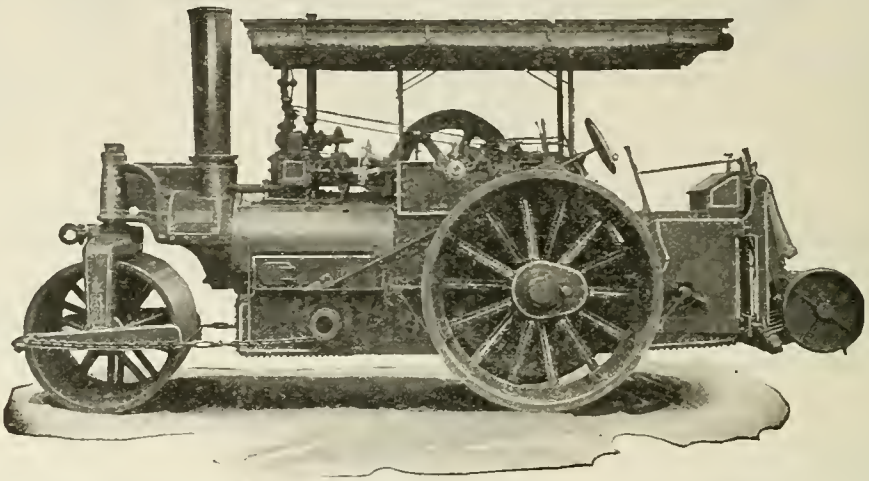

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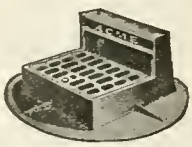

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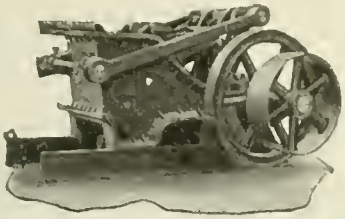

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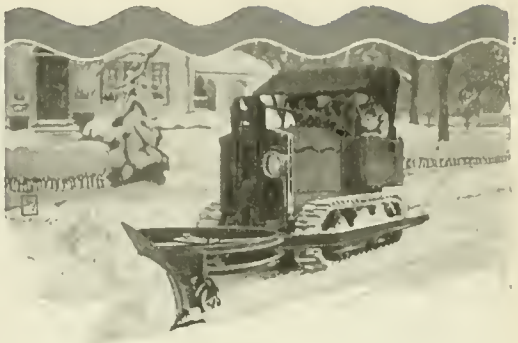

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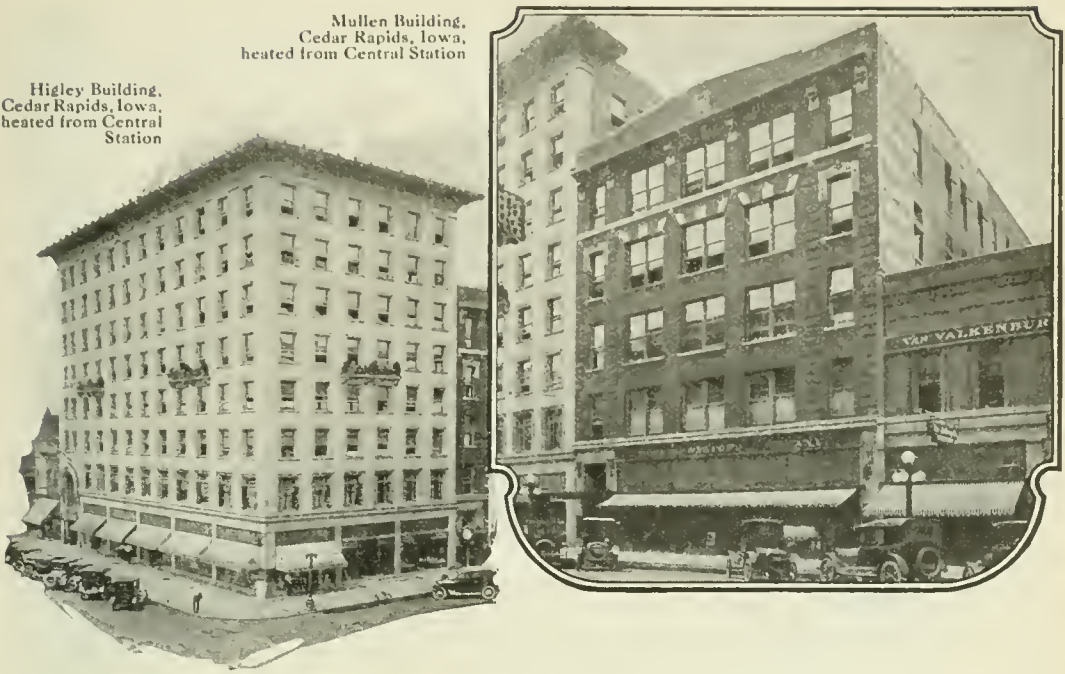
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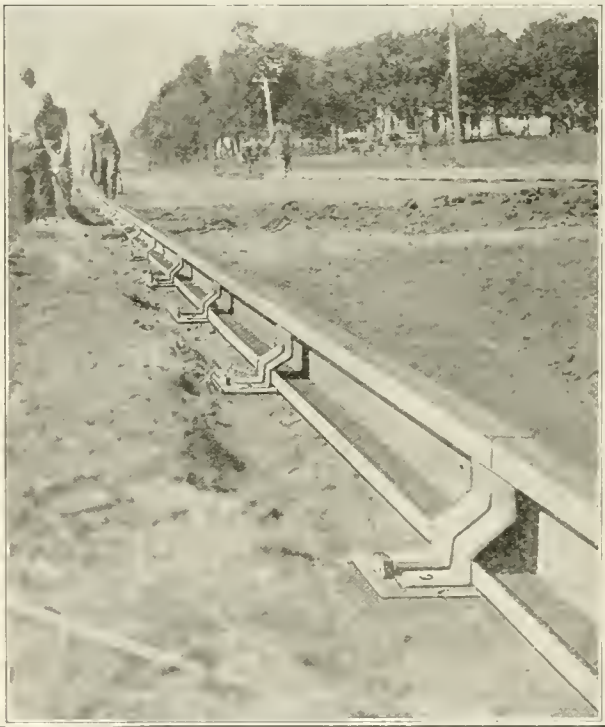

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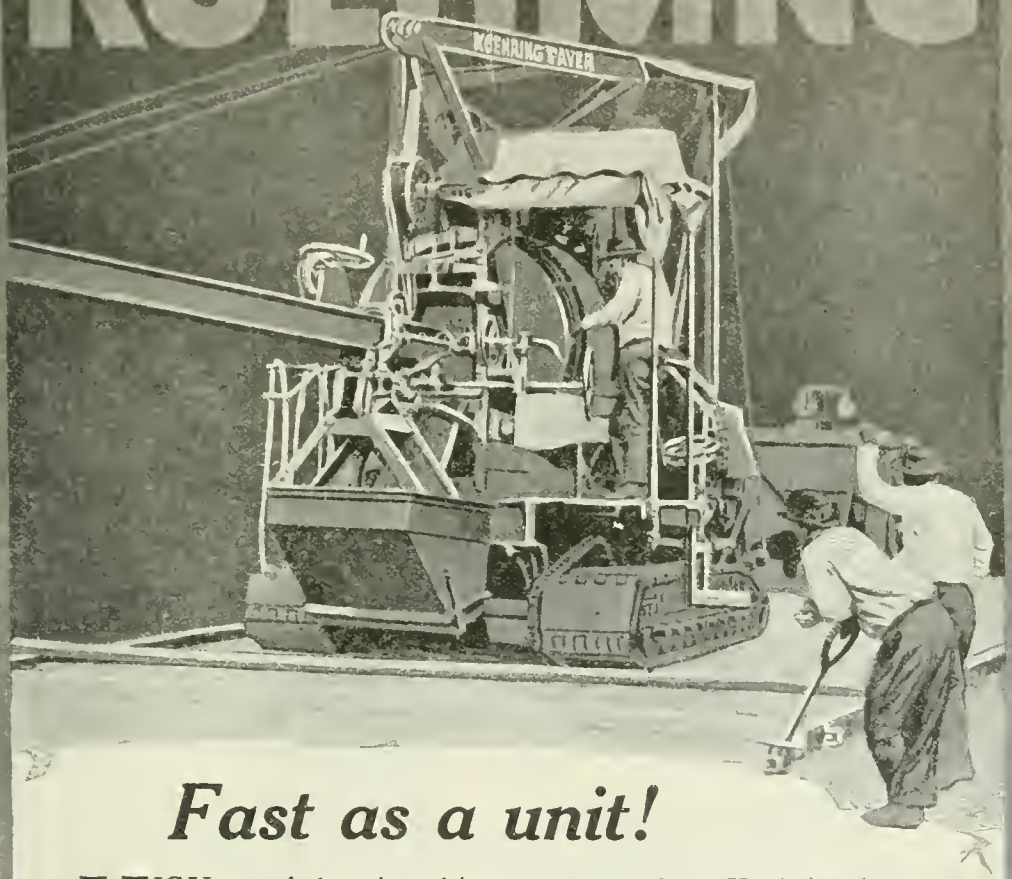

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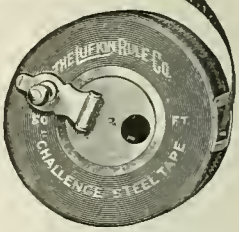

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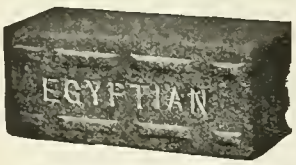

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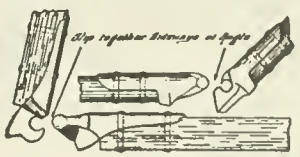

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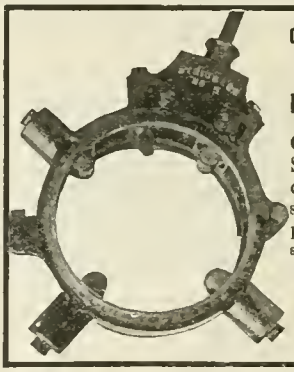

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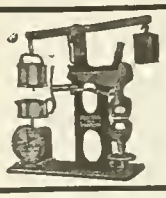

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EDITORIAL

THE CRAZE TO REGULATE MOTOR TRAFFIC

Public officials in every state and in every city are taxing their minds to evolve new methods of regulating motor traffic. There is a great volume of public sentiment favoring drastic forms of regulation, much of it fostered by interests opposed to highway development and to motor transportation. In some cities traffic regulations are changed so often that it is only by following the newspapers carefully from day to day that the resident motorist can operate his car without laying himself liable to arrest, fines and even imprisonment, while the tourist is totally unable to conduct himself in a manner to avoid harsh criticism. Cities are requiring city license tags in many cases and are not granting reciprocal courtesies to visiting motorists. A truck operator finds himself a stranger in a strange land when he crosses a state line and, often, when he visits a neighboring city in his own state. The freedom of movement by motor that has done so much in recent years to make this a real nation with a national conscience and viewpoint is endangered. We are trending backward toward provincialism. Soon we may be no better off than Europe where tourists sometimes are stopped at the border, searched, stripped and disinfected. Many unhappy possibilities exist in the present disposition to outlaw the motorized citizen.

There is at present an infinite variety of regulations governing every conceivable phase of motoring, ranging from proof of ownership on demand to where and how long one may park and on what thoroughfares and at what speed one may drive. Many mechanical features of the machine are subjected to regulation and every form of regulation of the use of the vehicle that ingenuity can conjure up has been tried at least once. Then there is the subject of taxation on the vehicle and its use, especially its uses as a common carrier and in general commercial operation. A multitude of regulations, many of them unfair, some of them purposely unfair, now vex the owner, drive the dealer mad and the manufacturer into bankruptcy.

The great motor industry cannot long survive these virulent spasms of regulation but it can adjust itself to sane, well-considered regulation. In fact, proper regulation will be welcomed by every owner of a vehicle but he wants sane and uniform regulation so that he can operate safely if he gets off his daily beat between his home and his office. The man who purchases a truck for any use and especially those who operate truck and bus lines have a right to know what regulations of all sorts will be imposed on them for a reasonable period in the future.

The very nature of motor traffic, its great range, makes attempts at purely local regulations ridiculous. Uniform regulation throughout the country is urgently needed in the interest of all. We understand an attempt will be made at the coming annual meeting of the American Road Builders' Association to formulate a recommended set of uniform highway traffic regulations for nation-wide use. These questions of traffic regulation, vehicle taxation, excise taxes, taxes and franchises on truck and bus lines, etc., are now of paramount importance. The use of the highway now looms larger than its construction and we hope all who attend the convention will go prepared to contribute something to the solution of the problems here mentioned and others of like nature too numerous to mention.

ADVERTISING GOOD ENGINEERING

The suggestion contained in the editorial in the November issue entitled: "Advertising Good Engineering" has received favorable comment. It was suggested that a fund be raised with which to purchase space in a popular magazine of large circulation and to use this space in educating the public to appreciate the money-saving possibilities of good engineering. It was further suggested that the fund be raised by subscriptions from engineers and engineering firms through the National Headquarters of the American Association of Engineers.

Typical of comment received on the suggestion is the following quotation from a letter from an engineer very high up in the municipal engineering service of the city of New York:

"Your editorial in the November issue regarding advertising the engineer has re-

ceived favorable comment from members of the Municipal Engineers of the City of New York. There seems to be a growing tendency on the part of engineers to adopt modern business methods for their own welfare, and indirectly what we believe will be the welfare of the community.

"As suggested by you, advertising in one of the largest publications or one of the most widely circulated magazines would probably bring the quickest results. However, before finances for such a campaign could be obtained, it would probably be necessary to do considerable advertising of the 'benefits' among the engineers themselves."

Another correspondent suggests an idea must "germinate" for a considerable period before it can be expected to bear much fruit.

This magazine will devote as much space to the advancement of this idea as engineers may consider advisable. We have agreed to devote a page in each issue, in the advertising section, to the task of selling the idea to engineers if some properly constituted body will utilize that space consistently in carrying out the details of a properly prepared plan for raising funds.

THE DICTATED ARTICLE

Engineers have often been urged, in these pages and elsewhere, to dictate short articles for publication, giving specific information of a practical nature. Receipt of such an article for use in this issue again reminds the editor of his enthusiasm over the possibilities of the dictated article.

The editor has received so many favors from the hands of contributors that he does not want to be understood as critical of articles that are written; his concern is over articles that might so easily be written but which the busy man does not find time to write.

Some articles require a vast amount of thought in their preparation. The amount of this thought depends on many things which it would serve no good purpose to enumerate. Suffice it to say that it does take a good deal of time, thought and effort to write certain classes of articles. But the article most wanted by readers is the short article, giving practical, up-to-date information and, unfortunately, the man in position to prepare such articles lacks the time to write them, or thinks he does which amounts to the same thing from the standpoint of production. The man in charge of a project has his head so full of details, both major and minor, and his time is so fully occupied in conferences and in other ways that he recoils from the suggestion that he write an article on his work while the work is in progress and when what he might give out would be of maximum value. Consequently he waits until the project has been completed and all the loose ends gathered up before he finds time to write anything. Then he writes ancient history from the standpoints of costs, labor conditions, material supply, transportation, etc. How unfortunate it is that he could not tell how he solved these changing problems from time to time while he was bearing their burden!

The dictated article is an easy and satisfactory solution of this problem. Men are seldom too busy to dictate a few letters each day and, while dictating, the engineer or contractor could get certain thoughts, impressions, facts and figures pertaining to his work, down on paper as a preliminary to giving this matter out for the use of his contemporaries. If the busy engineering executive will spend five minutes outlining the high spots on a particular job and another fifteen minutes in dictating a story based on his outline his stenographer and the magazine will do the rest.

The habit of dictating articles if at all generally practiced would revolutionize engineering journalism and would greatly increase the usefulness of engineering publications to their readers. We hope, since the season of good resolutions is at hand, that every reader of this editorial will resolve to dictate at least one short, practical article for this or some other publication for the year 1923. If this is done the construction industry will have made an important forward step.

By way of illustrating the value of the dictated article we respectfully refer the reader to the article published on page 245 of this issue entitled: Hints on Haulage of Lean Mixtures of Concrete. The author of the article has rendered a valuable service to all interested in road and street construction and he was able to do so only by having recourse to the dictated article. While this article was not dictated during construction it was *dictated* and, we submit, illustrates the very great practical value of short, dictated articles. But for previous suggestions along these lines the article to which we refer would never have become availabue for publication.

Methods Employed on Difficult Road Construction on Ozark Trail Highway in Eastern Arkansas

Swampy Soil Made Work Unusually Difficult—Drag Line Excavators Make High Fills—Special Attention to Drainage

By Albert S. Fry, Treasurer, Morgan Engineering Co., 620 Goodwyn Institute Bldg., Memphis, Tenn.

The Ozark Trail Road Improvement District of Poinsett County, Arkansas, is now completing ten miles of road, a part of which has presented unusual difficulties in road building because of the swampy nature of the soil along the location of about two-thirds of the road. The new road extends from Marked Tree, on the east bank of the St. Francis River, southeasterly to the south line of Poinsett County, where it joins with an improved road leading to Memphis, Tenn., a distance of about 25 miles from the end of the Ozark Trail road. The road is a part of the interstate Ozark Trail Highway, and is classified as a primary road by the Arkansas State Highway Department. Part of the lands across which the road is built are overflowed at certain seasons of the year and at such times Marked Tree has in the past been cut off from highway communication with the territory to the east, particularly with Memphis. This condition resulted in a demand for a road which would give Marked Tree access at all seasons of the year with eastern Arkansas and Memphis. To meet this demand the Ozark Trail Road Improvement District was created by a special act of the Arkansas Legislature in 1919. The District embraces an area of 51,300 acres and includes the town of Marked Tree and several smaller towns.

Nature of Country Traversed

The country through which the road

CONSTRUCTING OZARK TRAIL HIGHWAY IN EASTERN ARKANSAS.
Clearing Heavy Growth of Timber from Right of Way, Blasting Stump in Background —Dressing Embankment with Fresno.

passes is typical alluvial valley formation. The road extends across generally flat lowlands, especially by low ridges into valleys bordering the principal water courses. The main streams, Tyronza River, Dead Timber Lake, and a large drainage canal are crossed by the road nearly at right angles. The lowlands are overflowed whenever the streams are at high stages and remain wet and swampy for considerable periods of the year, the complete draining of these lands not yet having been carried out. The two chief ridges are one and two miles wide, and rising to about 10 ft. above the lowlands, are elevated above high waters.

Design

In designing the new road, the grade of the embankment was desired to be above maximum high water. Gage records on St. Francis River at Marked Tree for a number of years were available and high water marks were obtained on Tyronza River and the other watercourses which the road crosses. After thorough study of the high water records and data, the crown grade of the earth embankment was fixed at a minimum elevation of about 1½ ft. above maximum high water. On the ridges where the location is over ground, which is above high water, the grade was generally raised above the ground surface to secure drainage for these portions of the road.

The road follows along the south side of the St. Louis and San Francisco railroad. The railroad embankment, built many years ago, was constructed high enough to be above the elevation of Mississippi River overflow water if the levees on the Mississippi River broke, and long trestle openings were left through the embankment to pass Mississippi River overflow water. Since the railroad was built the levees along the Mississippi River have been so strengthened and have so successfully withstood extremely high waters that the possibility of overflow is now considered remote. Accordingly, in designing the embankment for the Ozark Trail road, Mississippi River overflow was not seriously considered. The railroad embankment serves to cut off all drainage from the north except that which comes through the trestles.

The standard road cross section adopted for the embankment had a crown width of 24 ft. and side slopes of 1½ to 1. Slopes of borrowpits were specified not to be steeper than 1 to 1 and a minimum berm of 5 ft. was required between the edge of the borrowpit and the toe of the embankment. The standard cross section was adhered to during construction except where material was encountered, which had a tendency to slide and at such places the embankment slopes were flattened.

To provide for shrinkage, 10 per cent excess material over the net cross section was required where teams and scrapers were used and 15 per cent required where drag line excavators were used.

Embankment Construction

The contract for the construction of the earth embankment was let June 2, 1919, and active construction work was begun a few weeks thereafter. Contract unit prices were as follows: Embankment, 45 cts. per cubic yard, clearing $40 per acre, grubbing $160 per acre, and clearing and grubbing $200 per acre.

Approximately one-third of the length of the road was on the ridge lands, where the fills averaged from 1 to 2 ft., and the embankment averaged 8,700 cu. yds. per mile. Building the road on the ridges was not difficult, because the work was dry and the fills light. This part of the work was done by teams with scrapers and fresnoes.

The remaining two-thirds of the road, some 6.6 miles, were located through the lowlands, where the fills were generally from 5 to 10 ft. and where the embankment averaged 24,300 cu. yds. per mile. This part of the work was particularly difficult on account of the wet, swampy nature of the ground during several months of the year, the heavy timber growing on most of the right-of-way, and the heavy fills which had to be made.

Five dragline excavators were used in building the embankment across the lowlands. The work could have been done with fewer machines had it not been for long delays caused by high water, which made work impossible for several months. Two of the drag lines operated on caterpillar treads, two on skids and the other on trucks. The booms on all the machines were 35 or 40 ft. long and the buckets were ¾ or 1 cu. yd. capacity.

Material for the embankment was taken from side borrowpits and the machines were required to excavate to a fixed grade line in order to secure drainage. The problem of securing material was complicated because many old borrowpits from which material had been taken for the railroad fill adjacent to the road extended beyond the railroad right-of-way

line on to the right-of-way for the highway, and thus decreased the amount of available material for the road embankment.

Clearing Right of Way

Before the embankment could be started the right-of-way, where it was wooded, had to be cleared for widths of from 100 to 125 ft. The land along the ridges and some of the lowlands was cleared, but most of the lowlands was covered with a growth of very heavy timber, such as cypress, tupelo gum and other swamp trees. Stumps were required to be removed to a depth of 2 ft. below the finished roadway, and where the fill was not more than 2 ft. the stumps and roots were grubbed out. Under embankments more than 2 ft. high, the stumps were cut close to the ground surface and were not grubbed out.

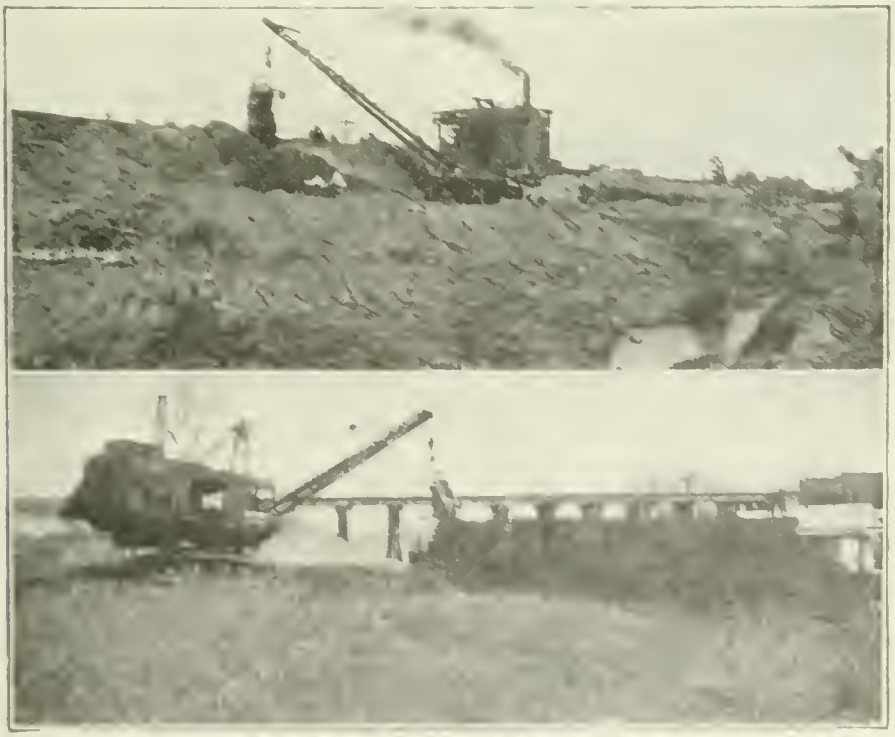
Hand labor and teams were used in cutting down the trees and snaking them off of the right-of-way. Stumps which had to be removed were blasted out by dynamite. Brush was piled and burned on the right-of-way.

Three of the dragline machines were installed on the work in July and August, 1919. At that time the bottom-lands were dry and it was possible to make good progress. One of the machines broke a main driving pinion a few weeks after starting work and was idle more than a month being repaired. In the early part of October, which is usually a dry month, very heavy rains occurred, which made progress very difficult. Water in the borrowpits made the digging slow and uncertain, and made it difficult to dig a satisfactory borrowpit ditch. The soft and slippery condition of the ground caused the machines to mire up and to slide off from their pontoons.

Winter Conditions

By November 1, water conditions had forced two of the draglines to shut down and by December 1 water covered the land where the draglines were working, so that it was necessary to suspend work for the winter until the water had receded from the land and the ground was dried out again.

Work was resumed again in March, 1920. In order to promote progress and complete the work before another win-



USING DRAG LINE EXCAVATORS TO MAKE HIGH FILLS ON OZARK TRAIL HIGHWAY CONSTRUCTION

Top: Constructing 8 ft. Fill; Machine Triple Cutting from Borrow Pit to Place Material. Bottom: Constructing Embankment at Concrete Bridge Approach

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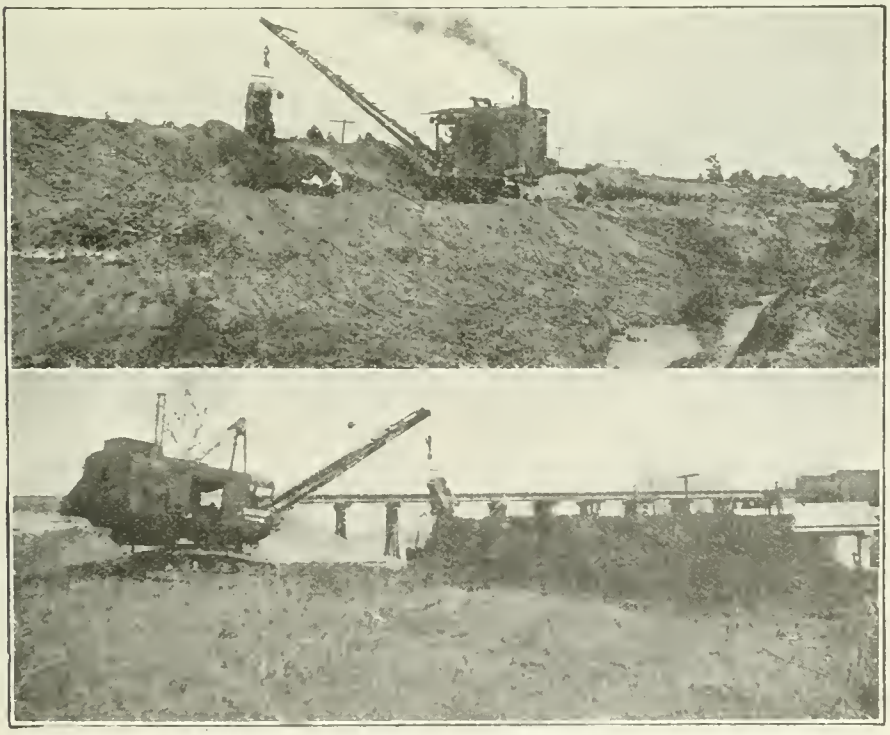

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ter's high water, a fourth dragline machine had been built during the winter and was ready to work in the spring of 1920. One of the small draglines already on the job did not start until in July. A fifth dragline was put on the work to help this macbine complete its section of the road. These two machines worked together until the completion of their work, one operating on one berm and the other on the opposite berm.

The fall of 1920 was dry and permitted work to be carried on until the end of the year by or before which time all of the dragline machines had finished the embankments. The embankment left by the dragline machines lacked much of being a finished road, and considerable work had to be done by teams or tractors with scrapers and graders in leveling off the fill and finishing up the roadway to an even crowned surface.

Performance of Dragline Machines

The five dragline machines placed 160,400 cu. yds. of earth in the road embankment. Of this amount one machine placed 53,200 cu. yds, another machine placed 35,700 cu. yds, and the other three machines each placed a little less than 24,000 cu. yds. each.

Where the depth of fill was not too great, the dragline machines set in the center of the road and excavating from both sides, built the whole road at one operation. Where the fill was too great for the material to be obtained within reach of the macbine setting in the road, the excavator traveled along one berm, excavating from one side only and throwing up material for half of the road. The machine completed the fill by traveling back along the other berm. Two of the draglines were worked together on part of the work, one operating on one berm and the other on the opposite berm. Where tbe fill was highest and around the abutments of bridges, some material had to be rehandled one or more times.

The smaller draglines used were able only to throw up the dirt in much the shape of a spoil bank along a drainage ditch. Where the fill was heavy and required working down one berm and back the other, pockets were created between the fill thrown up on the first and second runs. Unless leveled off immediately after the second run of the machine, these pockets caught and held rain and the earth could not be worked over and leveled down satisfactorily until the material dried out.

Some of the machines had booms long enough to level off the earth immediately after it was placed, and so were able to put the correct amount of earth into the embankment to meet the required grade line without difficulty. Where the machine was not large enough to level off the fill, it was difficult for the machine operator to tell when he had the right amount of earth inside the slope stakes.

Part of the difficulties from water in the borrowpits could have been avoided had the work been started in all cases at the outlets for the borrowpit drainage ditches. Where this was not done the pits filled with water back of the excavator and the machine either had to excavate under water or leave a dam in the ditch to be removed at a later time.

Notwithstanding the difficulties encountered, dragline machines were probably the best means for constructing the work under the existing conditions.

A large part of the material from which the embankment was made consists of a stiff gumbo soil characteristic of the alluvial lowlands of the lower Mississippi valley. This material does not dig so easily as lighter soils, and is difficult to work in, but when finally settled, compacted and shaped into a roadway, it makes a very satisfactory embankment. On about 2 miles of the road, material was encountered which had a tendency to slide on slopes of 1½ to 1. On these parts of the work the embankment side slopes were increased to 2 to 1, borrowpit slopes to 1½ to 1, and berms 12 ft. wide were left between the edge of the borrowpit and the toe of the embankment.

One borrowpit draining into Tyronza River had to be refilled in order to prevent the fluctuating river water undermining the roadway. This pit was necessarily large in order to provide material for the high embankment required near the river, and every rise and fall in the river washed away some of the silty berms until the road embankment was endangered to the point where the pit had to be refilled.

The right-of-way for the road is immediately adjacent to the right-of-way line of the Frisco railroad, and one of the road borrowpits is between the railroad and the road. In some places the toe of the high railroad embankment approached closely to or even extended beyond the right-of-way line. In one such case, trouble was experienced with a slide in the railroad embankment after the borrowpit for the road had been excavated. The railroad fill settled vertically and

pushed out laterally into the highway borrowpit for several feet, blocking up most of the pit. After this slide occurred the highway was relocated wherever there would have been danger of further sliding, so that a safe berm remained between the toe of the railroad fill and the borrowpit ditch for the road.

Drainage

In constructing roads through country such as the Ozark Trail road traverses, good drainage for the roadbed is of utmost importance. Where it is necessary to build high fills by dragline excavators, the greater part of the material for the embankment must be taken from immediately alongside of the road. On the lowest ground, where the fill is greatest, the depth of cutting which may be allowed in the drainage ditches is least. In order to secure the large amount of material required to make the high fills, it is either necessary to make wide shallow borrowpits at such places or to excavate the material with the drag line at some other location and pile it up in the road where it can later be rehandled by teams and moved to the desired part of the road. It is difficult, however, to work over the top of an embankment fill made by draglines, and hence every effort was made to lay out the work so that material could be obtained from borrowpits immediately along each side of the road with a minimum amount of rehandling. This resulted in variation in the width of the borrowpits in order to obtain sufficient material for the embankment and still excavate only to the fixed grade line. This was necessary, however, in order to give good drainage to the embankment by the side ditches and to prevent holes, which would not drain out being dug where the cuts were greatest. There was always a temptation for the dragline operator to cut below grade and a large amount of education by the resident engineers was necessary to prevent this practice.

In addition to the actual drainage of the roadbed itself, another reason for requiring borrowpits to be dug so that they would drain was that it was desired not to create any artificial mosquito breeding places. In flat country wherever borrowpits are dug so that they do not drain out, the low places in the pits hold water and form excellent pools for mosquitoes, particularly the anopholes or malarial mosquito. A special effort was made on this job not to do anything that might promote malaria.

For cross drainage on the road Nelsen pre-cast concrete culverts were used. These culverts are of horseshoe section, strongly reinforced, and are made in 2 ft. lengths. The 2 ft. sections were set in a reinforced concrete base which was poured in place. About 1,600 lin. ft. of 12, 18 and 24 in. culverts were used. For

CONCRETING ROADWAY ON OZARK TRAIL HIGHWAY IN ARKANSAS.

Finishing Concrete Surface with Machine After which Surface is Broomed Lightly—Protecting Green Concrete from Hot Sun with Canvass Frame—Covering New Concrete with Moist Earth.

larged sized culvert openings conforming to the standards of the Arkansas State Highway Department, were used. These were poured in place.

Bridges

The bridges on the road were constructed at the same time as the embankment work. Six hundred lineal feet of bridges were required. Steel girders were used across the main water courses and concrete structures were used for approach spans to the steel girders and for the smaller bridges. All the bridges

have roadways 18 ft. wide and are designed for a loading of 15 tons. The main bridges were founded on steel cylinder tubes filled with concrete and supported on wooden piles driven under the tubes.

The longest bridge is 244 ft. this being across Tyronza River. This is made up of 2 steel girders, each 50 ft long, and 9 concrete spans, each 16 ft. long. For uniformity and ease of construction, all concrete bridges and approaches were designed in combinations of spans each 16 ft. in length.

Concrete Surface

Much of the material in the embankments being gumbo soil which compacts very slowly, holds water with great tenacity and dries out very hard, it was necessary for the high embankments through the low lands to settle for several months before a hard surface could be safely built. Embankment constructed by dragline machines is not compacted as much as where teams are used, and this was an additional reason for delaying the placing of the hard surface. The embankment was subject to traffic as an earth road until the summer of 1922, by which time the earth had settled and compacted into a stable foundation for a hard road surface.

A contract was let in July, 1922, for a concrete surface to be placed on the embankment. This work is now under way. The concrete roadway is 18 ft. wide, 8½ ins. thick at the center, 6 ins. thick at the sides, and the surface slopes ¼ in. per ft. The concrete is reinforced with metal weighing 0.4 lb. per sq. ft. A 1-2-3 mix is being used. Three foot shoulders will be built and maintained along each side of the concrete surface.

Central Proportioning Plant and Industrial Railway

The methods being used for constructing the concrete surface are not unusual. Materials are mixed at a central proportioning plant and are transported to the mixer by an industrial railroad. After the concrete is poured and finished to correct cross section, the surface is broomed lightly. Canvas covered frames are placed over the pavement as soon as it has been broomed. The pavement is then covered with earth, which is kept moist for several days. The road is opened to traffic in sections 30 days after pouring.

Car shortage has resulted in serious delays in completing the concrete surface, because it has been impossible to obtain cars for materials.

Cost

Because of the high embankments required across the lowlands and the length of bridges necessary in crossing the watercourses, the cost per mile of the road is high. The embankment work, including clearing and grubbing cost, $95,230, and the bridges and culverts, $50,520. that the average cost per mile for em- The exact length of road is 9.8 miles, so bankment was $9,700, and for bridges and culverts $5,150, the combined average cost per mile without the concrete surface being $14,850. The concrete surface is costing $28,500 per mile, so that the total cost of the completed hard surfaced road will be $43,350 per mile.

Funds for the work are provided partly by a bond issue, which is being repaid from taxation of the lands in the district, and partly from Federal aid, which was granted on the entire road.

Engineers and Contractors

The contractor on the embankment work was the McWilliams Company, Inc., of Memphis. The culverts were installed by the Nelsen Concrete Culvert Company of Jonesboro, Ark. The bridges were built by Larimer & Burget of Memphis. The concrete surface is being constructed by the Hansen Construction Company of Blytheville, Ark. Surveys and plans for the district were made by the Morgan Engineering Company, Memphis, Tenn., and all of the construction work has been carried out under their direction. Ned H. Sayford, Vice-President of the Morgan Engineering Company, has been in direct charge of all the engineering work.

THE INEVITABILITY OF THE ST. LAWRENCE ROUTE TO THE SEA

By Francis C. Shenehon, Consulting Hydraulic Engineer, 628 Metropolitan Bank Bldg., Minneapolis, Minn.*

The St. Lawrence Waterway, destined to create an avenue for deep-draft vessels between the fresh-water seas of the Great Lakes and the salt-water seas encircling the globe—this waterway has been so much discussed in many addresses, in many magazines and in the public press, that the general features of it do not need further amplification or explanation here.

Perhaps at the present time, with a lull in the battle between those strenuously

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advocating this waterway and those strenuously opposing, it may be helpful to state, with some positiveness, the reasons why the obstruction of the opponents of this route is certain to be futile, and why the waterway itself will persist and become a fact.

The need of deep-draft connection between the Great Lakes and the salt seas has been long recognized. In a report made in 1897 by a distinguished board consisting of the then President of the University of Michigan, Dr. James B. Angell, John E. Russell and the well-known hydraulic engineer of that time, Lyman E. Cooley, recommendations were made for an extensive investigation of the various routes to tidewater which appeared to have any measure of practicability. The contemplated waterway was solely for navigation, because at that time water power appeared to be something that tended to block the enterprise because it must be condemned and paid for to get it out of the way; or else the navigational scheme must adjust itself to the existing water power situation at some cost.

The routes recommended for investigation by the earlier Commission were all focused on New York as the portal to the Great Lakes System, or as the port of exit into salt water. It is not probable that patriotism alone was the controlling element in this emphasizing of an American-Atlantic seaport as the outbound terminal for lake navigation. It was simply the fact that water power consciousness had not fully emerged.

The need of development of a great energy resource such as the St. Lawrence River was not clearly apparent, nor was the market for this power at that time available. In fact, now, a quarter of a century later, many engineers and investigators of the St. Lawrence route do not clearly visualize the market which will exist for all obtainable energy at the end of the period of incubation for the St. Lawrence waterway and the years necessary to its construction. The writer ventures the prophecy that ten years hence, or by 1933, a visible market will exist for the fullest development of the water power of the St. Lawrence River.

It must be understood that under the Federal Water Power Act, licenses are issued for water power use on streams coming within the jurisdiction of the Federal Government for a term of 50 years. Such a lease beginning in 1933 will continue to be in force until 1983, and then possibly renewed. It is a daring pessimist who fails to visualize the vast strides being made in electric current use in domestic life, in the arts and in the industries, as the years go by—not alone by reason of population growth, but by reason of the intenser use of electricity itself in all the phases of domestic and business life. The electric furnace alone, a tremendous absorber of cheap electric energy converted into intense heat, will utilize great blocks of power.

The writer, while he believes the St. Lawrence Waterway to be primarily a great navigational project, prefers to emphasize the water power element in this discussion, because it is the water power itself which must determine the preponderating desirability of the route of this necessary navigational avenue to the sea.

Other avenues—which are international in part, or all-American in full—exist, all of which focus on the port of New York. An all-American route follows the line of the present barge canal, leaving Lake Erie at Buffalo and entering the port of New York through the Hudson River. Another route departs from Lake Ontario at Oswego, N. Y., climbs up to the level of the barge canal and proceeds by the same route as mentioned above to the Hudson River and tidewater at New York. Other routes proceed down the St. Lawrence and then across to Lake Champlain and on to the Hudson River and the port of New York. These routes have, so far as the canalized portion of them is concerned, the vital defect of slow movement of vessels as compared with fast steaming through an open waterway. This means the loss of time by costly vessels with increased freight cost due to this time lost in transit. It means also that no adequate monetary assistance in the project itself will come from a partnership with water power which may bear a portion of the capital cost. Here, it will be observed, are two vital defects.

In demonstrating the inevitability of the St. Lawrence route, the writer wishes to set down as the first proposition: *The economic desirability of deep-draft connection between the Great Lakes and salt water is so obvious that it is axiomatic.* It is for this reason that Congress in 1897 followed the recommendations of the Angell-Russell-Cooley Commission, already referred to, and appropriated nearly half a million dollars for a thorough engineering investigation of the various routes between the Lakes and tidewater. As before stated these routes debouched into

the Atlantic through the port of New York. The personnel of this commission of engineers appointed by the President to carry out the purposes mentioned was so distinguished that the conclusions reached by these engineers must be given the highest weight. These engineers were Col. Charles W. Raymond, Alfred Noble and George Y. Wisner, and the report made by this Commission in 1900, after two years of work, is a monument of investigation and judical conclusions. Only 23 years later, in this day of intense electric energy use, it is interesting to note the fact observed before—that water power as a co-ordinate development did not substantially enter into any of the projects recommended.

In discussing the inevitability of the St. Lawrence Waterway to the Sea, the second proposition is: *The full use of the energy of the St. Lawrence River is an economic necessity which cannot be permitted to lie unused.* In this stream four million electric horsepower are awaiting the command of the people of two nations to take up innumerable tasks, to assume innumerable burdens which now rest upon human shoulders, to illuminate the night and make to blaze countless electric furnaces. These will produce steel, malleable iron castings, ferroalloys now so necessary in the arts, aluminum, graphite, fertilizers, carbide, carborundum, bleaching powder and various other desirable commodities. It is simply unthinkable that one of the most opulent power resources in the world should long remain unused at a time when the usable power in the Niagara River has reached—and possibly exceeded—the limits of the treaty agreed upon with Great Britain; at a time when a distinctly inferior water power on a flood stream at Muscle Shoals is being fought for with avidity—it is simply unthinkable that this vastly superior energy resource of the St. Lawrence River should remain unused.

In discussing the inevitability of the St. Lawrence River Waterway, the third proposition is: *The route where both water power and navigation co-exist is the logical and certain route from the inland seas to the salt seas.* In other words, the way the water goes to the sea is the way navigation must go also. The water power cannot be developed without developing navigation as an incident, and navigation, itself the paramount thing, cannot be developed without incidentally creating great water powers. What the writer has been endeavoring to show is briefly this: The eternal forces of Nature, operating geologically, have already carved and fixed the pathway to the sea, and in this pathway the vast volume of the surplus waters of the Great Lakes outflow; and it is inevitable that commerce must take the same route.

What are the obstacles which temporarily delay this inevitable thing? First, the fact that geological forces in carving the channel of the St. Lawrence River made two nations proprietors of the channel. The St. Lawrence River for only a portion of its length is an international boundary stream; the river then departs into Canadian territory as it continues its descent over the rapids to Montreal, and then through the deep wide channel of the lower river passes to the Gulf of St. Lawrence. Two nationalities mean the need of treaties which will determine the proprietorship and conditions of use of the vast volume of electric energy to be produced. The question of navigation, so far as the dual nationality element is concerned, has no great substance as a deterrent for this particular route. Under existing treaty provisions, free and unrestricted use of the St. Lawrence River and of the Great Lakes on equal terms is accorded to each nation without discrimination as to whether the channel lies in American or Canadian waters.

Much more intense than the element of internationality is the element of provincial or state or some other group opposition which may find in this waterway to the sea a possible local loss. It is quite easy to see why New York State, so far as the navigational element is concerned, should not wish to see commerce avoiding the port of New York; but, on the other hand, New York State, within a distance of one to two hundred miles of the St. Lawrence River, will be the chief American beneficiary of the electric energy to be produced. The State of New York has therefore a divided loyalty in the matter of this waterway project—a desire to have the energy of the water power development, and a desire to keep all possible commerce threading through the port of New York, which is antagonistic to a water power development on the St. Lawrence, if it become also a great deep-draft waterway. Montreal, as the terminal for up-bound ocean traffic, with all the profitable business of transfers between ocean carriers and rail, cannot—with human nature such as it is—view favorably vessels flying the flags of

all nations passing by her wharves without contributing to the business prosperity of her port. Buffalo hates to lose this desirable business—which really represents to the nation at large economic loss—of cargo transfers from lake carriers to railroad cars or to canal boats.

It has been said that the project to create a single union station for all railways in a great city is not favored by the baggage and passenger transfer companies enjoying the business of these transfers. An undertaker might not look favorably upon a purified water supply, which might interfere with his business.

In the end the international element will find a solution. The opposition coming from local interests, as opposed to the interests of the people as a whole, will dissolve by the very futility of endeavoring to obstruct a thing which all economic considerations point out as right. For those interested in obstruction, the best to be expected is some temporary delay, for the waterway of the St. Lawrence is the way the water goes, and it is therefore the way that commerce also must inevitably go.

STEAM AND HEAVY OIL COMBUSTION ENGINES FOR MUNICIPAL SERVICE

By John W. Hill, of John W. Hill & Sons, Consulting Engineers, 45 Bodmann Bldg., Cincinnati, Ohio.

The superiority of the heavy oil engine, in point of fuel efficiency, for small and moderate powers has been amply demonstrated, and its substitution for steam power in municipal service in cities of 25,000 population and less, will result in such a reduction in operating cost as to justify the abandonment and scrapping of many of the smaller plants, and their replacement by more modern equipment for pumping water and sewage and for generating electric current.

There are many situations where the substitution of the oil engine with direct driven or geared pumps, either turbine, centrifugal or plunger pumps, will within a short period of operation effect a saving in fuel charges sufficient to cover the cost of new equipment, and eventually provide a fund for other improvements or lower the charges for service.

Aside from improved fuel economy the oil engine has the further advantage over steam power of the absence of boilers under pressure, and all the hazards and trouble and expense connected with them. The smaller space required for a complete power plant and its cleanliness and conveniences are also arguments in favor of oil outfits when compared to steam.

As a rule the fixed charges, interest and depreciation are larger for the oil engine power, and the item of oil for lubrication is also larger. Information on repairs and general upkeep is not so satisfactory as on other items, but according to the British reports the oil engine can in this respect hold its own with steam.

Simplicity favors the oil engine, all the requisites being combined in a single machine, while the steam engine, whatever form it may take, requires a steam boiler, and for best results a superheater, feed pumps, feed water heaters, fuel economizer possibly, and a towering chimney.

One room will accommodate the oil engine and this need not demand more floor space than the equivalent steam power, while two rooms are required for a steam power plant.

When electric current can be obtained at low rates its convenience and cost of service will make this the most desirable. In fact, it is the ideal power for municipal service even if required for large units, and water power used direct or electrically from a well developed source will usually supply municipal needs at lower cost than steam or oil engines. But the great majority of the smaller cities and towns are so located as to be beyond the reach of cheap power, excepting it can be developed at home, and the strictly local controllable sources of power generally speaking are the steam engine, the oil engine and the gasoline engine.

The cost of fuel, coal, oil and gasoline, in any locality, and to a certain extent the size of power required, usually determines the matter.

Power for municipal service, must from reasons of prudence always be considered in duplicate or rather be so designed that the service may not be interrupted or impaired by the shut down of any one unit, and where one unit is of sufficient capacity to carry the whole load, then at least another unit of equal capacity must be provided, so that the patrons must not at any time be deprived of the service; because, generally, they are wholly helpless in case of interruption or impairment of service. This may seem to be a self evident fact, but even some large and well organized cities have suffered inexcusable interruptions of public power service at frequent intervals, so that when

a city or town undertakes to supply a public service of any kind, it must be prepared to do it continuously without interruption and at the least cost to the citizens, all things considered.

This article is written to impress upon public officials the importance of serious thought of oil engines as a source of motive power, but it cannot be assumed that there are no drawbacks to the use of the oil engine in place of the steam engine. The consumption of lubricating oil for the oil engine is much larger in quantity than for steam engines and forms a significant element of operating cost. The cost of repairs and maintenance is said to be larger for the oil engine, and these adverse conditions must not be overlooked in comparing operating costs. If the cost of fuel, coal and oil or their equivalents, was constant for years everywhere or anywhere, then a definite relation between the operating costs of these two kinds of power could be established. In a locality where, or at a time when, coal is cheap and oil is dear the question is promptly decided in favor of the steam power, and of course converse conditions favor the heavy oil engine. In establishments where considerable steam or steam heat is required, the steam engine usually seems to fit the conditions best.

The lack of natural gas in all but a few favored localities, and the price and lower B. T. U. for artificial gas naturally limits gas engines in the aggregate to a small field and small capacities, and gasoline at current prices has become impossible for the development of continuous power of any magnitude. During the past 25 years the Diesel oil combustion engine has undergone wonderful improvement and a type of oil engine known as the Semi-Diesel has been developed to a high fuel efficiency.

With the oil combustion engine there are no stand-by charges, when the engine stops the consumption of fuel stops, and no fuel is used until the engine is started in service. Not so with the steam engine, much fuel is used in warming up the boilers and furnaces, in starting and raising steam to working pressure, and in banking fires, and that burned out on the grate after the power is shut down, all of which must be considered in arriving at the fuel cost of power.

The cleanliness and convenience of the oil combustion engine is obvious.

It may be said that many important steam installations are dependent on heavy oil for fuel, notably the marine service, some of the latest and largest ships being supplied with oil burners under the steam boilers. Oil is also largely used in locomotives and in factories for steam where conditions favor it, and no proposed installation of motive power is halted for fear of the early prospective loss of heavy oil as a power fuel. Keep in mind, however, that if crude oil is used for generating power, it will give a higher efficiency in the combustion chamber than it will under a steam boiler.

Small or moderate powers for municipal service, pumping water or sewage or generating electric current, are now usually obtained from steam, gas, gasoline or oil, and rarely from water power, because commercial water power today is generally converted into electric current at its source, and conveyed to users through the well known wire conductors, and is so used in many instances for pumping water and sewage in municipal service. Water power used direct for pumping municipal water supplies in the early history of water works in this country was found in Fairmount Sta., Philadelphia, Pa., Indianapolis and Ft. Wayne, Ind., Rochester and Lockport, N. Y., Middletown, Troy and Piqua, Ohio, and many other places in the East and Middle West, where such power was available.

Many early water works operated by water power were supplied with steam machinery for auxiliary purposes and for emergencies, and in due time steam pumping machinery came almost into universal use for municipal pumping. In the larger cities no other power was available 25 years ago, and the High Duty compound and triple expansion pumping engine has attained and holds a high degree of economy in cost of operation.

For small cities of moderate power requirements steam engines have not been economical in fuel consumption and necessity has been the prime factor in promoting the substitution and use of oil, gas and gasoline power for this service. Aside from reduced operating costs, the absence of steam boilers, boiler rooms, stokers, feed pumps, feed water heater, and other necessary adjuncts of a steam outfit, together with lower first cost has recommended the use of gas and gasoline power in place of steam power. Gas has a more limited application than gasoline because the latter is not universally available and gas engines are seldom used outside the radius of distribution of natural gas.

Artificial gas is, however, also used, and

is convenient if not economical for small requirements where natural gas cannot be obtained.

In comparing the costs of steam and oil power, the fixed charges or interest and allowance to a reserve fund, sufficient, either by the sinking fund method or otherwise, to discharge the original investment at the end of the useful life of the machine, or combination of machines, should be taken on at least two units of the power service, either of which must be capable of easily maintaining the service. While the operating charges regardless of the number of power units will always be figured as the cost of furnishing the service, wages, fuel, repairs, etc. To be exact the item of water consumption for steam power, and for cooling purposes for oil power should be considered in comparing operating charges.

If the service requires two or more power units to maintain it, then one additional unit of capacity equal to the largest unit which may go out or be taken out of service must be considered in arriving at the item "fixed charges" in power cost. In small electric and pumping works for water or sewage this usually means that the power machinery will be in duplicate.

The frequency of strikes in the coal fields, and accompanying high prices of coal, and difficulty in obtaining it, naturaly suggest other sources of motive power than steam, where these are available. Oil can be transported as broadly and conveniently as can coal, and wherever railroads, steamboats or motor trucks can deliver coal they can also deliver fuel oil. The price of fuel oil is not fluctuating like the price of coal, and a power user can therefore figure with more confidence on his fuel cost than if coal were the fuel used. It might be urged that coal is a mere certain power fuel through a long period of time in the future, but the prospect of heavy oil and other fuels adaptable to the oil engine gives this source of power a probable life sufficient to cover all hazards of fuel exhaustion during the useful life of the motor.

Coal and oil as fuel for power can be readily compared in any locality upon the following basis, prices being changed according to location.

Assume steam coal at $5 per ton, heat value at 12,500 B. T. U. per pound of coal; then 1,000,000 B. T. U. will cost 20 cents.

Assume heavy fuel oil costs 5½ cents per gallon, heat value 18,500 B. T. U. per pound of oil, and welght 7½ lbs. per gallon; then 1,000,000 B. T. U. will cost 39.5 cents.

This shows an oil cost of twice the coal cost, but the relative fuel efficiency for the oil engine will be more than 2 to 1. It may be in many existing instances for small powers 6 or 8 to 1, so that with steam coal at $5 per ton and fuel oil at 5½ cents per gallon, it can safely be assumed that the heavy oil engine will be the best investment.

This does not take into account the increased cost for the oil engine of lubricating oil, grease and waste, but if this cost should be as much as 15 per cent of the combined cost of fuel oil and lubricating oil, etc., there will still be a relative fuel efficiency in favor of the oil engine of 5 to 7 to 1. Dividing these figures by 2, the relative fuel costs, there is a final fuel efficiency and fuel costs combined, of 2½ to 3½ in favor of the oil engine.

The heat efficiency of a large vertical triple expansion crank and fly-wheel pumping engine, showing a test duty of 200,000,000 ft. lbs. per 1,000 lbs. of high pressure superheated steam, equivalent to about 1 lb. of high grade coal per I. I. H. P. hour, is about 33,75 per cent of the B. T. U. in the oil.

The heat efficiency of a heavy oil combustion engine of the Diesel type of 150 to 250 BH. P. with fuel oil of 19,000 B. T. U. per pound, and consupmtion of ⅜ lb. per H. P. hour, is about 35.75 per cent of the B. T. U. in the oil.

But this relation is shown between a small capacity heavy oil engine, of which there are many, and a large high duty pumping engine, of which there is only one or perhaps two. As it is, on the data assumed, the power cost of fuel per I. H. P. is about in balance.

There are several hundred horizontal duplex direct acting steam pumps, many compound, some condensing, now in daily municipal service, showing heat efficiencies of five or less per cent of the B. T. U., in the coal expended in developing the pumping power, which can be displaced by heavy oil combustion engines, driving geared duplex or triplex pumps, or centrifugal pumps with a saving in the cost of fuel sufficient to pay for the new outfit within a few years, and thereafter be a source of saving for other necessary improvements.

In comparing steam and oil engines for small powers, there is to be considered the relative fixed charges on the cost of

installation, and in this must be included all items necessary to the completion of the equipment. Account must be taken of the useful life of the engine and its adjuncts in order to determine the time to run an annual allowance for redemption charges. If the plant is a new one and comparison of investment costs (steam and oil) is properly made, it will be often found that the cost of the oil engine complete, including the heavy foundations, will be less than the cost of the complete steam equipment.

NEW WATER SUPPLY SYSTEM AT BRAINERD, MINN.

By George M. Shepard, Associate with Louis P. Wolff, Consulting Engineer, 1000 Guardian Life Bldg., St. Paul, Minn.

While improvements in water supply systems in cities of 10,000 population, the size of Brainerd, Minn., may not generally be of unusual interest, there are some features of this system which are of interest to municipal engineers.

The original water works system in Brainerd was constructed by a private company. In 1909 the plant was purchased by the city of Brainerd from the Minnesota Water Works Co., and since that time has been operated by a Water and Light Board. Shortly after taking over the plant the old station burned and the mains, which under private ownership had been largely constructed of kalomine and wrought steel pipe, began to develop a considerable amount of leakage. It became evident that the city would soon have to undertake the construction of practically a new system. Such a proposition was considered a number of times between 1909 and 1917, but was delayed on account of the war.

During the latter part of 1918 Mr. Louis P. Wolff, Consulting Engineer of St. Paul, Minn., was employed to make an investigation, report and estimate of the cost of a water works system which would meet the requirements of the city. Under the direction of Mr. Carl Zapffe, a geologist, President of the Water and Light Board, a great number of borings were made in the vicinity of Brainerd in an effort to locate a suitable well supply. A gravel bed yielding a water of excellent quality was eventually located in a flat bordering the Mississippi River directly southwest and within the city limits.

The Consulting Engineer's report, after giving careful consideration to a lake supply from a distant source, a filtered water supply and a well supply from the gravel formation just mentioned, recommended the well supply both on account of its proximity and lower cost, also the rebuilding of the water main system, the construction of a storage reservoir of 800,000 gals., and an elevated tower and tank of

FIG. 1—REINFORCED CONCRETE WATER TOWER AND TANK AT BRAINERD, MINN.

300,000 gals. capacity, together with high service centrifugal pumps, with gasoline engine auxiliaries for fire service, in addition to the two 6-in. motor driven centrifugal pumps then in service.

A bond election for the sum of $300,000 was placed before the people in the early spring of 1919. Following an interesting educational campaign upon the general subject of pure water supply, the bond election carried by a large majority.

The contracts were let for the various items of the work during July, 1919, the city buying the cast iron main and pumping equipment f. o. b. cars and laying the mains, installing the machinery and sinking the tubular wells by its own forces.

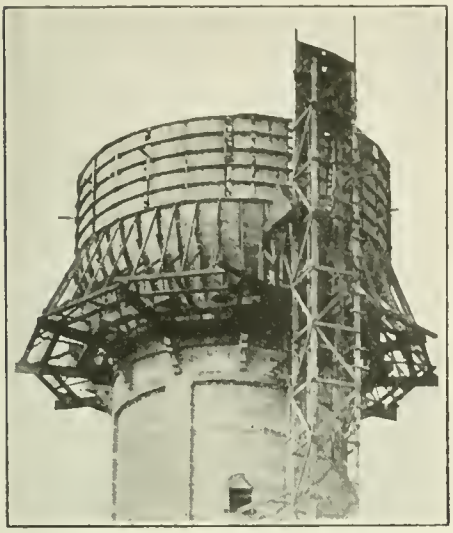


FIG. 2—FORMS FOR CONSTRUCTING LOWER PORTION OF BRAINERD, MINN., CONCRETE WATER TANK.

The supply is derived from two groups of tubular wells and one reinforced concrete open well 40 ft. in diameter, each of the groups and the open well being equipped with a low service centrifugal pump for discharge to the reservoir. A sufficient area was purchased by the city to allow for the extension of the well system indefinitely to provide an increased supply. Well group No. 1 consists of four 8-in. wells 91 ft. deep, with 15 ft. screens, these wells being connected to the suction of a vertical motor driven centrifugal pump set in a well pit at the junction of the lines connecting the four wells. Well group No. 2 consists of three 8-in. wells 72 ft. deep, with 12 ft. screens and one 8-in. well 105 ft. deep, with 36 ft. screen. The yield of well group No. 1 is approximately 700 G. P. M., of well group No. 2 approximately 900 G. P. M. and of the open well approximately 800 G. P. M.

For the elevated tower and tank bids were received on both a steel and concrete tank of 300,000 gals. capacity on a 90 ft. tower. The bid for the concrete tower of the design shown in Fig. 1 was $28,574 by W. S. Hewett of Minneapolis, Minn., while the bid for the steel tank was approximately $25,000. In view of the fact that the tower was located in the central portion of the city and it was advisable to provide a structure of as ornamental design as possible, the concrete tower and tank was selected. The concrete tower and tank, with footings complete, contains approximately 1,000 cu. yds. of concrete. The height of the tower is 90 ft., and of the tower and tank combined is 134 ft. from ground line to top. The tank proper above the bowl is 40 ft. in diameter and is supported by two concentric rings of concrete, the inner ring 8 ft. in diameter and the outer ring 31 ft. in diameter. The new structure is of reinforced concrete, the side walls of the tank having a thickness of 12 ins. Fig. 2 shows the forms for constructing the lower portion of the tank.

The pumping equipment consists of two 6-in. Allis-Chalmers pumps, which were moved from the old plant, and two new 6-in. 3-stage horizontal Midwest-Hill pumps. The 6-in., 3-stage pumps are for

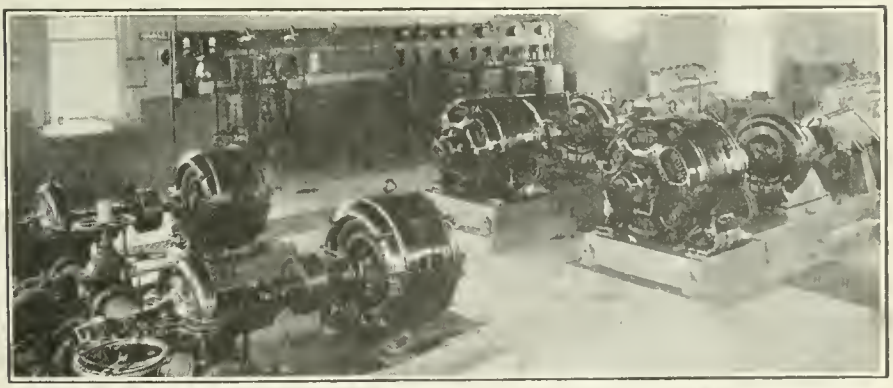


FIG. 3—INTERIOR OF PUMPING STATION AT BRAINERD, MINN., SHOWING SWITCHBOARD AND MOTOR DRIVEN CENTRIFUGAL PUMPS.

fire service and are rated at 1,000 G. P. M. each, against a total head of 275 ft., each pump being connected at one end to a 125 h. p., 3 phase, 2,200 volt, induction motor, and at the other end to a 136 h. p., 6 cylinder Van Blerck gasoline engine. Space is provided in the station for additional domestic and fire service units. The transmission line is run to a bus bar in the rear of the switchboard in the station, from which connection is made to the various units. Both the domestic and fire service pumps in the station and the low service pumps at the well groups are controlled from the station. Fig. 3 shows the interior of the station, with pumping equipment and switchboard.

The new system has been in operation since the early summer of 1920. Mr. Louis P. Wolff was Consulting Engineer on the above work, with Mr. R. T. Campbell, City Engineer, acting as Resident Engineer.

PRACTICAL SIGNIFICANCE OF SOME ROAD MATERIAL TESTS

By F. H. Jackson, Senior Assistant Testing Engineer, Bureau of Public Roads, Washington, D. C.

In the following discussion the writer desires to call to the attention of engineers who may not be particularly familiar with the technique of highway materials testing some points which should be borne in mind when interpreting the results of test data. It is frankly from the standpoint of the testing engineer, and is based on experience in this field, insofar as non-bituminous materials are concerned for a period of about 15 years.

The art of testing road materials has by no means attained the perfection of an exact science. Some of the tests now in use were first proposed and adopted many years ago when the necessity for adequate premliminary research was not realized quite so much as it is today. The result is that certain tests have been firmly established by custom and long usage, which are admittedly weak in some particulars. The so-called Deval abrasion test for rock and the "tensile strength ratio" determination for concrete sands are typical examples. Because these tests are not technically perfect, however, is no reason why they should not be used. They can be made to serve a very useful purpose, provided the engineer understands wherein the tests are weak and makes due allowance therefor in his interpretation of the results.

The very rapid changes within the past few years in the design and types of pavements in use, caused by changes both in the volume and character of traffic, likewise continually call for modifications in testing methods to meet new conditions. As an illustration of this point, the cementation test for rock may be cited. This test was used quite extensively in the days of water-bound macadam road construction, but is now practically obsolete. The standarization of tests is at best a slow process, and when one considers the frequency with which new conditions arise, it is not surprising that some of our methods of tests have failed to attain the perfection which certain critics seem to expect.

Another point which is overlooked frequently in studying test data is the question of availability of material. Although this is a matter primarily for the specification writer, experience has shown that many specifications contain requirements which cannot be met with any available material. It is well, therefore, that the engineer be familiar with the range in quality as shown by test results of all materials which could compete with those which he is examining.

Looking at the proposition from another angle, a third essential requirement is that he be familiar with service results obtained with materials similar to those in which he is interested. This particularly applies to such naturally occurring products as rock, sand, gravel, etc. The proper selection of such materials in any case can only be made by studying the test data in the light of all of the service indications which it is possible to obtain. Likewise, in the examination of tests of manufactured materials such as Portland cement, paving brick, etc., it is desirable that the engineer know something of the previous service and characteristic weaknesses, if any, of the particular product he is investigating. For instance, he may know of a certain mill which may be grinding cement so as just to pass the specifications. He will naturally scrutinize results of fineness tests on this product more carefully than where he is reasonably sure from past experience that the mill is well within the limit.

It will be seen from the above that to pass judgment intelligently on the results of laboratory tests is not quite so simple as might be supposed. Summing up briefly, anyone who would make the best use of such information must know enough about the methods of tests em-

ployed to be able to apply reasonable tolerances, he must be familiar with the general character and range in quality of all available materials, and he should know something of the previous service rendered by similar materials in the type of construction involved.

A brief discussion of some of the more commonly used non-bituminous road materials along the lines suggested above follows:

Portland Cement

Portland cement is probably the most universally used of all of the manufactured materials employed in the construction of roads. There is hardly a street or highway of any kind built in which cement is not used, either in the base or surface course of the pavement or in the construction of drainage structures, curbs, etc. The present requirements of the Bureau of Public Roads specify that all cement used in Federal Aid construction must be tested regardless of the amount involved. Practically all Portland cement is now manufactured under the specifications and is tested by the methods prescribed by the American Society for Testing Materials. Several years' experience in testing this material has convinced the writer that, although these methods of tests are far from perfect, they are sufficiently accurate when properly conducted to detect inferior cement. The words "properly conducted" are used advisedly because there are many laboratories which are unfortunately carrying on routine tests of cement in an incorrect manner. Throughout this paper, however, it will be assumed that the laboratory methods in use conform to the best practice, and that what variations in results are obtained are due rather to inaccuracies in the test itself than to carelessness or ignorance on the part of the laboratory. The present specification limits for Portland cement have been set so low, particularly as regards tensile strength, that there should be no difficulty for any standard brand properly manufactured to meet the requirements. For this reason the writer would be inclined to adhere rigidly to the present American Society for Testing Materials' requirements, except possibly in the case of the fineness test, where a 1 per cent tolerance is permissible to cover unavoidable variations in testing.

In thin connection it is well, in interpreting fineness test results, to be sure that a standardized cement sieve is used. Cement No. 200—mesh sieves now on the market are apt to vary as much as 3 per cent from the true value. All reports of fineness tests should indicate that the result has been corrected and should give the correction factor. The United States Bureau of Standards will standardize cement sieves for a nominal charge. Results of tests for time of set are usually well within specification limits. Due to the large personal equation involved in this test, no significance should be attached to variations within the limits. About the only value the test has is to detect a flash set. If a flash is reported, however, the cement should positively not be used until it has been thoroughly re-tested and found to be O. K. A word also about the soundness test may not be amiss. A mere report of unsoundness by the laboratory is not sufficient cause for rejection. Unsoundness is caused by the hydration of an excess of free lime, which produces distintegration in the cement by reason of its increase in volume. If a cement showing such unsoundness is stored for a period of two or three weeks prior to use, the chances are that the lime will air slake and thus become inert. Cements therefore which are unsound when first tested should always be held for a sufficient period to allow this slaking to occur, after which they should be retested, and if sound, accepted for use.

Concrete Aggregates

The strength and durability of concrete depends fully as much on the character of the aggregates used as on the quality of cement. For this reason a number of tests have been devised and requirements established for both fine and coarse aggregates for the various types of construction.

Fine Aggregates

Fine aggregates, that is, sand, stone screenings, or combinations thereof, are usually subjected in the laboratory to four routine tests; grading or mechanical color test for organic impurities. This is, of course, in addition to tests on the concourse, in addition to tests on the concrete fabricated from the aggregates being investigated. A discussion of the significance of these laboratory tests, as they apply to the use of sand for concrete road construction, will serve to call attention to some points which are not always appreciated by engineers. The grading of the concrete sand is an important consideration apart from any other test. If the sand is too fine, a weak mortar and a low resistance to wear will be produced.

If, on the other hand, it is too coarse, a harsh open mix difficult to work and with a consequent tendency towards the use of too much water will result. The average specification for sand controls the grading within safe limits. The trouble has been that many engineers look upon the test for mechanical analysis as secondary to the strength test, and are inclined to waive the former if the strength be within the specification requirement. A knowledge of the relations existing between the various tests would show that many sands much too coarse for satisfactory use in concrete will show very high strength ratios. Results of the strength test under these conditions are very misleading, because of the natural assumption that the higher the strength, the better the sand. The point to be emphasized here is that the strength test should only be considered in conjunction with the grading. If this is done, the strength of the sand for any given grading will be an indication of its quality. Thus, for a normally graded concrete sand, that is, one showing about 20 per cent coarser than a No. 20 sieve, a strength ratio of 100 per cent indicates satisfactory quality. A lower strength is an indication either of the presence of some deleterious substances such as organic matter, or that the sand grains are of poor quality. An unusually high strength invariably indicates a very coarsely graded sand. The color test for organic impurities alone is only an indication of danger, because there are substances found in concrete sands such as lignite, small particles of coal, etc., which show an unfavorable reaction and are still entirely harmless. If, however, the sand when normally graded shows low strength the chances are that the substances causing the color are of a harmful nature. If, on the other hand, the normally graded sample shows a low strength and no organic impurities, the trouble is undoubtedly due to poor quality of grains. Tests for silt content are usually positive indications, especially if the determination has been made by weight. Presence of silt in any sand which is to be used in a concrete surface exposed to wear is of course undesirable, for this fine material tends to work to the surface and greatly weaken it. The usual specification allows a limit of 3 per cent, and in concrete road construction it is seldom wise to exceed this limit. The term "silt" in this connection is used to cover only the material lost in the elutriation or washing test. It is usually composed of clay, loam or excessively fine sand, considerably finer than a No. 200 sieve. Ordinary fine sand passing a 100-mesh sieve is not harmful in amounts less than 10 per cent, providing the silt content is low.

Coarse Aggregates

Stone, gravel or slag which is to be used in the construction of concrete pavements should, in addition to being structurally sound, possess sufficient resistance to wear to withstand the abrasive action of traffic. This is particularly true in the case of city streets, which are subjected to an appreciable steel-tired traffic. The most commonly applied test for coarse aggregates is the Deval abrasion test. It was designed originally for use in testing macadam stone. The need for some form of test for quality of coarse aggregate led to its adoption for this purpose, in spite of the fact that there are many engineers who believe that it is wrong in principle when used in this connection. The test can be applied either to stone, slag or gravel. The methods of testing, however, are somewhat different, so that the results are not directly comparable. Opinion differs as to the proper test limits to apply when selecting aggregates for pavements. Many concrete roads constructed of stone with a percentage of wear as high as 6.5, or even 7.0, have given good service. As in the case of other materials, however, the best available aggregate should be used, and it is for the purpose of comparing available materials that this is of particular value. Although, as stated above, there is no direct relation between the results of abrasion tests of stone, gravel and slag, numerous laboratory tests have shown that, in general, these materials when of approximately equal quality will show results in the ratio of about 1:3-2. That is, gravel with a percentage of wear of 15 and slag with a percentage of wear of 10 will be of approximately the same quality as stone with a percentage of wear of 5. It will be observed that no reference is here made to the French coefficient of wear. Testing engineers are now practically unanimously in favor of abandoning this term. It really has no added significance, being merely the quotient obtained by dividing the constant 40 by the percentage of wear. It is rather difficult to discontinue the use of the term, however, because almost all highway engineers are accustomed to think only in terms of coefficients. With regard to tolerances, which should be allowed when interpreting this test, it is probable that, in general, the test is not accurate to less

than 0.5 per cent for stone or 1 per cent for slag or gravel, the difference being due to the fact that stone is usually more uniform than either of the other aggregates. Such a liberal tolerance is made necessary simply because the test cannot be depended upon to give results with any greater degree of accuracy. Many attempts have been made to improve the method, but so far none of them has been adopted as standard.

Although stone may be tested for hardness, toughness, etc., in addition to the abrasion test, the writer believes that the latter is sufficient control when the material is to be used for concrete aggregate. In the case of stone to be used in the construction of bituminious macadam or bituminous concrete roads, however, the toughness test has been found to be of value. In the case of gravel, uniformity of quality is the most essential requirement. This means freedom from soft, disintegrated fragments, and an impact test has been developed for determining the percentage of such fragments in a gravel sample. Sufficient data has not as yet been accumulated to permit setting any test limits. For slag, density is the chief requisite. To determine this a test for weight per cubic foot of crushed slag is made. The usual requirements specify a weight of 75 lbs. per cubic foot for pavements. Many good slag concrete roads have been built, however, with slag running as low as 70 lbs. to the foot. It would seem, however, that this is about as low as one should go until further information regarding the use of light slag in pavements is available. The Bureau of Public Roads has constructed and is now testing an experimental concrete pavement in which a large number of samples of stone, gravel and slag of widely varying characteristics are used. The results of this test should throw considerable light on this important question.

The proper grading or size of coarse aggregate will depend on the type of construction. Practice as regards concrete pavements varies in different parts of the country, a maximum size of 2¾ ins. being allowed in many of the Eastern states. The chances are that the maximum size is not an extremely important factor provided the aggregate is well graded from coarse to fine. A sample showing anywhere from 60 to 75 per cent retained on a screen intermediate in size between the largest and the smallest may be said to be satisfactorily graded. The maximum size of 2¾ ins., which is allowed in Pennsylvania, New Jersey, etc., is largely due to the added cost of further crushing the very hard and tough trap rock quarried in this section. Experience so far seems to indicate that the large stone is satisfactory.

In applying tolerances in connection with results of grading tests, it has been the custom in the past to allow a variation not to exceed 5 per cent larger than the maximum size or smaller than the minimum size, which is usually ¼-in. This is all right in theory, but does not work out very well in practice because, as is well known, stone, in general, retained on a ¼-in. revolving plant screen will often contain as much as 15 per cent passing a laboratory screen of the same size. Likewise, the efficient working of some gravel pits requires that the coarse aggregate carry considerable "tolerance" material. Purdue University recently conducted a series of tests to determine to what extent this so-called "tolerance" material was harmful, resulting in the conclusion that as high as 15 per cent might be allowed without seriously affecting the strength of the concrete. The principal consideration affecting control tests for grading of aggregates is that the material runs fairly uniform from day to day. This is usually determined by testing with a set of field screens right on the job or at the producing plant. One additional point in connection with screen analyses of aggregates should be mentioned. Some specifications call for the material to be the product of the crusher passing a revolving screen with openings of a certain size, say 3 ins. and to be retained on a revolving screen with openings of a certain size, say 1 in. Everyone who has had experience with crushing plant practice will realize how uncertain such a specification is. There are so many factors which influence the size of a stone product, such as the speed and angle of the screen, amount of moisture on the stone, etc., that the only safe plan is to specify that samples of the products be of definite size, as determined by laboratory screens. Knowing these requirements, the quarry man can adjust his equipment so that they can be complied with. It will be found that this is a much safer plan than to be compelled to accept aggregates simply because they were produced in a plant having screens of certain specified size.

Stone for Macadam

Turning now to stone to be used in macadam construction, we find not only

the abrasion test, but the toughness test and sometimes the hardness test used in examining the material. In a macadam road, the stone being held in place by a more or less non-rigid binder, is not supported on all sides to the same extent as the coarse aggregate in concrete. For this reason there is more chance for the individual fragments to wear in the macadam type, and consequently a greater necessity for a tough, durable stone, especially under heavy traffic. The engineer is justified, therefore, in taking only the best available stone, and the laboratory may often be of considerable assistance to him in making his selection. Good practice does not in general recommend the use of stone for bituminous macadam where the per cent of wear is more than 5.5. The toughness likewise should be at least 6.0. For mixed bituminous concrete a per cent of wear of not more than 5.0 and a toughness of at least 8 is usually required. The type of stone should also be taken into consideration. Many engineers specify a lower percentage of wear for trap or granite than for limestone for a given construction. This is done because the trap and granite are naturally much harder than the limestone, so that a trap showing a percentage of wear greater than normal is likely to be distintegrated or otherwise to be of inferior quality to the limestone, even though the actual wear as shown by the test is the same. Type is also an important consideration if water-bound or plain macadam construction is used. It is well known that certain types, such as the quartzite, gneiss, schists, etc., will not bond on the road, and for this reason they should not be used in the wearing course. Simple determination of type of road is all that is necessary in this case, which is partly the reason why the so-called "cementation test" for rock is not now used to any great extent.

Gravel for Surfacing

The testing of gravels for road surfacing is confined largely to a washing test to determine the percentage of clay present and a mechanical analysis to determine the grading of the sand and gravel from the maximum size down to dust, with the gravel fraction weighing about 2-3 of the total. Just enough clay should be present to act as a binder. The amount of clay to be allowed will depend on the character of the gravel, ranging from as little as possible in some limestone gravels to as high as 10 to 15 per cent by weight in pure quartz gravels. The maximum size will vary with condition but as a rule should not be placed at more than 2-3 the depth of the course when the gravel is to be used as a base and not more than 1½-inch for topping. The tendency recently has been for smaller gravel in the top. In order to control the quality of gravel for wearing course, an abrasion course is sometimes specified. Although when two or more available deposits are under consideration it is certainly advisable to take the one in which the best grade of stone occurs, it is not usually economically justifiable to reject local in favor of imported material simply on the score of an abrasion test. For this reason the writer would be inclined to waive this requirement under ordinary conditions provided the material was otherwise satisfactory. Due to the wide range in grading of the average gravel pit, it is essential that rather liberal tolerances be allowed if the road is to be built. For instance, it is hardly practical to reject pit run material which varies from 50 to 75 per cent retained on the ¼-in. screen. It is simply impossible in the case of most pits to secure material which will run any more uniform than this. Again, if a specification calls for a 10 per cent clay content, some tolerance, say 5 per cent, may be allowed. It is seldom wise to allow a clay content in any case in excess of 20 per cent.

Paving Brick

About the only test to which vitrified paving brick is now subjected is the standard rattler test. This test has been used a great many years and has given, in general, entire satisfaction, although the writer believes that it, in common with many other tests, can be improved. About the only point to which attention should be called here is the effect of size and type of brick on the rattler loss. It is known that repressed brick will lose slightly less than wire cut brick of equal quality due to rounded edges of the former. Likewise, 3-in. brick will show a somewhat greater percentage of wear than 4-in. brick of equal quality due to the greater number of linear inches of edges in proportion to weight which are exposed to wear. In the absence of specific data, one would probably be safe in allowing a 1-in. differential in favor of the wire cut type over the repressed and a 1 to 2 per cent differential for a 3-in. over a 4-in. brick.

Stone Block

Considerable trouble has in the past been experienced in the testing of stone

block chiefly because of the attempt to apply the macadam stone tests to this material. The writer has discussed this point a number of times and it will not be necessary to go into details in this paper. Suffice it to say that the Deval abrasion test is not accurate enough to differentiate between the various grades of granite block on the market except in a very rough way. In other words, in using this test, no attention should be paid to a few tenths of a per cent variation. The test will indicate the presence of soft, inferior stone and this is about as far as it can be depended upon.

Conclusion

In a paper of this length, it is, of course, impossible to go very much into the details of this important subject. It is hoped, however, that enough has been covered to indicate the major points to be considered. The object of the paper is to show the necessity of taking certain things into consideration when interpreting test data and when setting specification limits for materials. The fact that these things are not always considered is, the writer believes, the principal reason for much impractical interpretation of laboratory results. It is largely a question of mutual understanding, and the writer sincerely hopes that this paper will contribute at least slightly towards clearing up some of the doubtful points.

The foregoing paper by Mr. Jackson was presented before the recent annual convention of the American Society for Municipal Improvements.

PROTECTING HIGHWAY BRIDGES AGAINST FIRE

(Editor's note: The report of the Co-operative Committee on Fire Prevention in Highway Bridges is here presented in full. The committee personnel is as follows: Chairman, George W. Booth, Chief Engineer, National Board of Fire Underwriters; L. T. Ericson, Chief Engineer, The Jennison-Wright Company; C. M. Taylor, past President, American Wood Preserver's Association; D. F. Holtman, Construction Engineer, National Lumber Manufacturers' Association; C. J. Hogue, Manager, West Coast Forest Products Bureau; F. E. Schmitt, Associate Editor, Engineering News-Record; Secretary, E. F. Kelley, Senior Highway Bridge Engineer, United States Bureau of Public Roads.)

During the past few years a number of serious fires have occurred on important bridges and the circumstances attending these fires have indicated the desirability of making a detailed study of the situation in an attempt to bring out the important factors governing the fire hazard in timber bridge construction. With this purpose in mind a co-operative committee was formed representing fire protection, highway bridge construction, lumber, creosoting and the public interest, as given by the signatures hereto.

An extensive correspondence has been carried on with city, county and state bridge engineers, and with this and information collected from other available sources as a basis the committee submits the following report:

Fire Risk

The existence of a fire risk in bridges having wooden floors must be recognized. An indication of the importance of this risk is the fact that on some heavily traveled city bridges small fires are of daily occurrence during the summer months.

Mr. John D. Stevenson, Assistant Chief Engineer of the city of Pittsburgh, makes the following statement:

"The city has several steel bridges having wooden floors. Some of these are large structures crossing the rivers, and are important arteries of traffic. During the hot dry periods of the summer fires on these bridges are very frequent. They are of minor importance only, because we have been successful in extinguishing them before the flames have taken much of a hold. During the last summer on one bridge fires were a daily occurrence, and not infrequently two or three fires occurred in one day."

The annual report of the Fire Commissioners of the city of Holyoke, Mass., for the year 1921 states that during the year "the department responded to 170 fires on the various bridges. The month of June was particularly prominent in this respect, when the department responded to 64 alarms for bridge fires. This epidemic was lessened in the months to follow through the efforts of the Board of Public Works in sending the sprinkler over the county bridges frequently during the day. While the department has been very fortunate in the past in extinguishing bridge fires at a minimum loss, there is always danger of such a blaze getting so much headway as to cause the loss of one of the bridges."

In practically all cases the cause of these fires is stated in the report of the Fire Commissioners to be cigarette stubs.

The available evidence indicates that this risk is much less for country bridges than for city bridges, and is greater on long bridges than on short ones.

Causes of Fires

On city bridges fires are most commonly caused by the lodgment of lighted cigar or cigarette stubs in cracks or depressions where chaff and debris have collected. Decayed or splintered material in the floor adds greatly to the fire risk. In the case of country bridges the greatest risk is from forest and grass fires.

Other reported causes of fires are: Sparks from locomotives or steamboats, hot coals dropped by steam rollers, traction engines, tar kettles or other construction equipment; burning waste dropped by street cars; defective insulation of electric wiring; defective bonding of rails and lack of capacity in return feed wires of electric railways; fires in adjacent structures.

Relation of Preservative Treatment to Fire Risk

Creosoted material appears to be somewhat more difficult to ignite than untreated material, but once ignited it creates a fire which is hotter and more difficult to control, and which is known by experience to be more destructive than fire in an untreated floor. However, decayed or partially decayed untreated wood is very easily ignited and has been the cause of many fires. The likelihood of fire is increased by treatment which results in excessive bleeding of oil, such as might be caused by the heavy treatment of green lumber. It should be noted that freshly creosoted material is much more inflammable than that in which the treatment is several months old. It is urgently recommended that orders for creosoted material be placed as far as possible in advance of construction, and that the material be seasoned for from three to six months after treatment.

Where it is practicable to do so, freshly treated timber may be rendered more fire resistant by thoroughly coating the upper surface with sand. The application of sand should be continued as long as there is any bleeding of oil.

Construction

In general it may be stated that tightly laid floors, in which cracks are eliminated to a large extent, are most fire resistant.

Mr. Thomas J. Wasser, State Highway Engineer of New Jersey, states that prior to January, 1922, the old Raritan River bridge at Perth Amboy was decked with closely laid rough plank flooring, and that, to his knowledge, no fires were reported during the life of that floor. The deck was replanked with heavier lumber, surfaced on two sides and one edge, and laid with ½ inch openings. Since that time there have been seven small fires on the bridge, and it has been necessary for the department to put on a fire patrol to meet these conditions.

The relative fire risk of various types of floor may be stated as follows, beginning with the most fire resistive: Wood blocks on concrete base. This type of floor may be said to have no fire risk; wood blocks on plank sub-floor; laminated floor of 4 in., 6 in. or 8 in. strips laid on edge and spiked together, with a bituminous wearing surface; plank floor, with bituminous wearing surface; laminated floor without wearing surface; multiple thickness plank floor; single thickness plank floor.

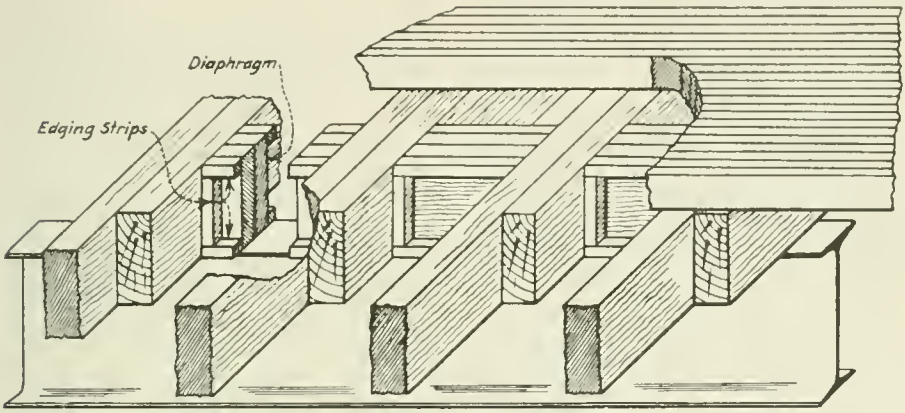
Steel joists or stringers supporting floors of any of the above types reduce the risk of rapid spread of fire by reducing the amount of combustible material exposed. Where wood joists or stringers are used the fire risk will be reduced by using heavy timbers for these members. The massing of combustible material renders it less susceptible to ignition and the spread of fire, and lessens the probability of serious structural damage before the fire can be controlled, in case fire-fighting means are at hand.

Special care should be exercised in the design of the floor and its supporting structure to avoid ledges or pockets in which trash may collect. The possibility of the accumulation of rubbish on truss members and in floor openings made for the passage of these members should be given careful consideration. In cases where such construction will not interfere with the proper disposal of floor drainage, curbs on timber floors should be constructed with ample clearance between curb and floor so that trash may have an opportunity to blow away.

To check the spread of fire lengthwise of the bridge the spaces between stringers, in cases where these rest on the floor beams, should be filled with tightly fitting diaphragms over each floor beam. Perhaps the most practicable method is

to use wooden diaphragms at least 6 ins. thick, which may be made up of two thicknesses of plank spiked together. Strips or battens should be placed around the edges of these diaphragms to cover cracks due to imperfect fitting or shrinkage. The accompanying sketch indicates the recommended construction.

In cases where limitation of headroom is not a factor, fire curtains of sheet metal extending at least 5 ft. below the bottoms of the joists and spaced at intervals of about 50 ft., will be of material assistance in preventing the spread of fire. The



SKETCH OF FIRE STOP DIAPHRAGMS OVER HIGHWAY BRIDGE FLOOR BEAMS.

corrugated asbestos-covered metal, as used for siding and roofing of buildings, is suggested for this purpose.

Maintenance

Floors, ledges and pockets and bridge seats should be kept free from street sweepings and other trash.

In the case of country bridges, particularly timber trestles, all underbrush, small timber, drift and debris, underneath and for some distance on both sides of the bridge should be removed. Grass and weeds should be cut in the early Fall and drift should be removed after floods. Where the vegetable growth is heavy, chemical weed killers are recommended as being economical and efficient.

Frequent inspections should be made of any conductors of electricity which may exist on the bridge.

Floors should be kept free from splintered and decayed wood.

Provisions for Fire Fighting

For bridges where watchmen or bridge tenders are employed, water barrels, sand boxes or water mains may be employed to advantage for fighting fires. For bridges not under constant supervision the value of any of the above is questionable, although sand boxes would probably be most likely to be ready for use when needed.

Water barrels and sand boxes should be covered and the surface of the water in the barrels should be covered with a light film of oil.

In cold climates freezing of the water in barrels can be prevented by the addition of a suitable amount of calcium chloride.

When water mains are provided they should have hose connections every 50 ft. and hose reels every 200 ft. In cold climates they must either be protected against freezing or be kept empty with provisions for supplying them with water under pressure, either from hydrants direct or from fire engines.

Watchmen and drawbridge tenders should be provided with at least one 2½ gal. soda-acid fire extinguisher. Where aid may be expected from a municipal fire department, there should be provided some means of transmitting alarms. If watchmen or bridge tenders are on duty, a telephone may be considered as a substitute for the more reliable and satisfactory public box on a fire alarm telegraph system.

Maintenance of the under-structure and the use of fire fighting appliances will be facilitated by providing under the bridge floor, on each side of each pier and at intermediate points not more than 100 ft. apart, platforms constructed of fire resistive material. Access to these platforms may be secured either by hatchways in the bridge deck or by stairs on the outside of the bridge.

In cases where fire streams from hose

and nozzles are available, there should also be provided at 20-ft. intervals, both longitudinally and transversely, openings in the bridge deck to permit the use of cellar pipes, revolving nozzles or similar devices. These openings should be not less than 10 ins. in diameter, and should be provided with metal covers, which can be easily removed but not readily displaced by accident.

Fire Retardant Paints or Treatment

The weight of the evidence, obtained from laboratories which have investigated this subject, is to the effect that, whatever may be expected from future experimentation, there is at present little that can be accomplished in the way of rendering wood fire resistive by means of a paint coating or other treatment by chemical methods. A paint coating which is not readily combustible may, however, serve to delay slightly the time in which the lumber reaches its maximum susceptibility to ignition. The difficulty with the chemical treatment is that the chemicals will either wash out or, if waterproof, are not fire resistive.

Conclusion

The investigation having shown that the subject of bridge fire protection is of an importance not previously recognized, the committee desires to emphasize the need for giving consideration to the fire risk in the design of highway bridges. Public officials having bridges in their charge have a clear responsibility in the matter, and the committee desires to call to the attention of such authorities the desirability of protecting bridges by due care in design and construction, by watchful maintenance, and by provision for preventing and fighting fires.

FARMERS GET FIRE PROTECTION THROUGH GOOD ROADS

Dallas County, Texas, has made it possible for its rural districts to obtain protection from the fire department in Dallas through the construction of modern hard-surfaced highways. A contract executed recently between the Dallas City Commission and the County Commisioners provides for fire protection to farmers on all paved roads within a radius of fifteen miles of Dallas. When a farm house or barn along a paved road catches fire all the farmer has to do is to telephone the Dallas department and it will respond at forty to fifty miles an hour with a chemical engine or a steamer, as occasion may warrant.

Dallas county is one of the first in the country to make such an arrangement. Several fires have already been extinguished with small loss. A general reduction in fire insurance rates in the smaller towns and farming districts has been the result. The service will be made more extensive when the big road building program now under way in Dallas county is finished. Farmers affected by the arrangement are reported to be delighted with the protection afforded.

CONSTRUCTION OF MILWAUKEE ACTIVATED SLUDGE SEWAGE DISPOSAL PLANT

By R. R. Lundahl, Assistant Engineer, Milwaukee Sewerage Commission, City Hall, Milwaukee, Wis.

General Arrangement of Plant and Design Features

Conditions foreseen in the operation of a large activated sludge sewage disposal plant, suggested an arrangement similar to that of a large mechanical water filtration plant. Referring to Fig. 1, showing the plant layout, it will be seen to consist of 24 aeration and 15 settling tanks; one row of aeration and one row of settling tanks on either side of the east and west center line of the plant.

The sewage, after having passed through the grit chambers and fine screens, and after having received the proper amount of activated sludge at the outlet end of the fine screens, will pass through the mixing channel between the fine screens and the plant and will enter the main channel at the extreme western end of the plant. At this point, the flow will divide, a portion going north and east to feed the north aeration tanks and a portion going south and east to feed the south aeration tanks. Eech tank is separated into two compartments by a baffle wall. The sewage enters the west compartments through feed pipes, and leaves through overflow weirs and meters placed in the ends of the east compartments. The outlet pipes pass through the two feed channels and discharge into the mixed liquor channels surrounding each settling tank on three sides.

The settling tanks take their supply from the mixed liquor channels through submerged gates, the effluent being collected in troughs which discharge into the effluent channels. The "settlings" or

TABLE I.

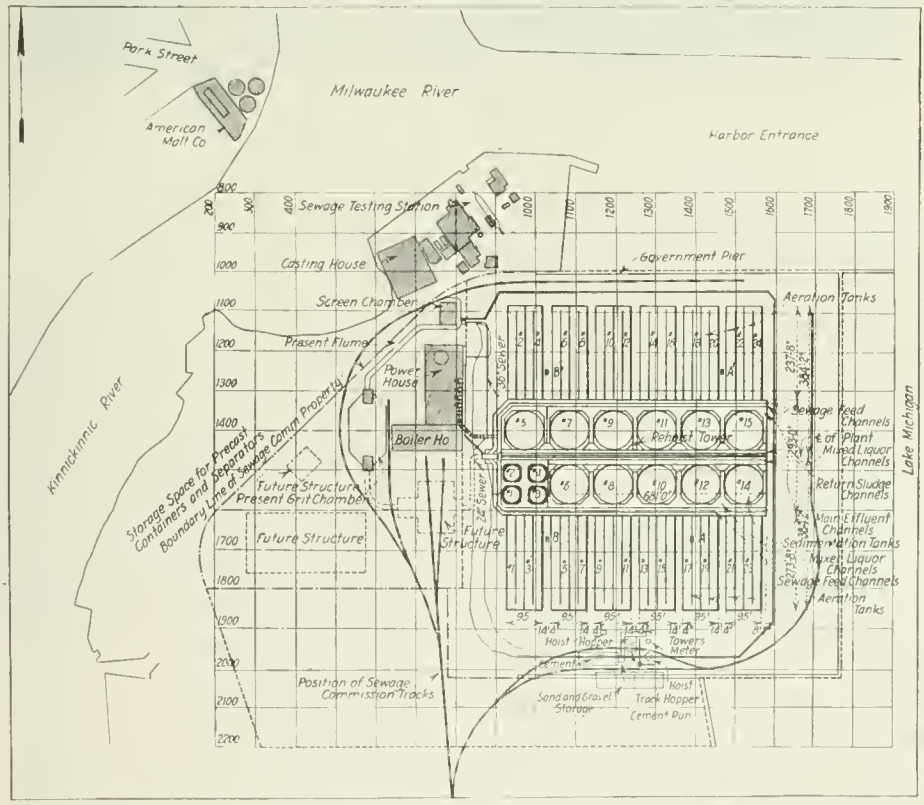
	Average	Aver. With Storm Water	Maximum	Max. With Storm Water
1914	50,283,000	51,583,000	75,400,000	113,210,000
1930	85,183,000	86,483,000	127,800,000	165,610,000
1950	128,775,000	130,075,000	193,200,000	231,010,000

sludge is withdrawn from the bottoms of the tanks and conveyed to the return sludge pumps located in the northeast corner of the main power house. From these pumps it is forced to the point of feed at the fine screen outlet previously mentioned.

The plant being constructed at the present time is calculated to provide treatment facilities for an estimated 1930 population of 588,750 inhabitants. Table 1 shows the estimated average and maximum rates of sewage flow per day for the disposal plant design:

The plant is based on the treatment of 15 million gallons per acre per day, for the net area of the sewage surface in the aeration tanks. The tanks have an effective depth of 15 ft. and with a 20 per cent by volume of activated sludge in the mixture, the detention period will be approximately six hours. The tanks are of such a size that they will treat an average of 3,580,500 gallons each per day. The size of the settling tanks are based on the figure of 1,600 gallons per square foot per day, determined from our experiments. This figure pertains to the number of gallons of sewage which can be settled every 24 hours on each square foot of horizontal liquid surface and does not include 20 per cent mixture of sludge in the sewage. The tanks are 98 feet in diameter at the bottom and octagonal at the top, the sides and corners being on a 2 to 1 slope so that there can be no deposits on the sides of the tanks.

The bottoms of all of the channels excluding the effluent channels will contain air diffuser plates as well as the entire bottoms of the aeration tanks. Only the area of the plates in the tanks was con-



GENERAL PLAN OF MILWAUKEE ACTIVATED SLUDGE SEWAGE DISPOSAL PLANT.

sidered in the design so we will have the added factor of safety of all the aeration that takes place in the several channels.

The quantity of sludge to be withdrawn from the settling tanks is to be controlled by the difference in head between the elevation of the sewage surface in the tanks and the elevation of the ends of the adjustable draw off pipes. It is estimated that the plant will produce sludge at the rate of 15,000 gals. (98.5% moisture) per million gallons of sewage treated, the total quantity for 1930 being approximately 1,275,000 gals. per day.

All excess sludge created will be pressed by Oliver Filter Presses and then dried down to a 10 per cent moisture content. The type of drier to be used has not as yet been selected but practically any type of commercial drier can handle the material after it has been dewatered in the presses to an 80 per cent moisture content. The dried sludge will be sold as fertilizer base, as it contains from 5 per cent to 7 per cent available nitrogen.

Construction of Plant

Actual work on the construction of the sewage plant was started in 1918. At this time the main valve chamber, coarse screen house, pump well and grit chambers, were constructed. In 1920 about 10 acres of Lake Michigan were reclaimed, forming land for the location of the aeration and sedimentation units of the plant. In 1921 the foundation piles were driven for the aeration and sedimentation tanks (22,500 wood piles) and the foundations of the power house and boiler house were built.

In April, 1922, the contract for building the aeration and sedimentation units of the plant was awarded to the Du Pont Engineering Co. of Wilmington, Delaware; the steel superstructures for the power and boiler house were completed in August, 1921, and work on the masonry started immediately and is now nearing completion.

Activities were started by the Du Pont Co. early in May, 1922, setting up their plant and equipment. In Fig. 1 a railroad track surrounding the entire area is shown; this track, the property of the Sewerage Commission, was turned over to the Du Pont Co. to use as they saw fit, and accordingly it was incorporated in the scheme of the plant layout. The plant was planned so as to use the Insley tower and spouting system for placing all the concrete.

By referring to Fig. 1 the plan of the plant layout is shown. Track hopper, storage hopper, cement storage, mixers and two main hoisting towers, electric hoist for the main towers and the stiff leg derrick used in handling the sand from storage and from cars, are shown. The storage piles for sand and gravel are so indicated. Fig. 2 is a view of the storage hopper with elevating conveyors and the foundation for the track hopper in the foreground. This plant was intended to place all the concrete for the south half of the plant. Fig. 3 shows the plant ready for operation. The high line from the main towers to the mast derrick, supports the line of spouts and the derrick carries a conical hopper and counterbalance chutes covering a radius of approximately 200 ft. The mast derrick was first set up at "A" Fig. 1, and later at "B." The main towers are 216 ft. high and the derrick is located approximately 300 ft. from the towers.

FIG. 2—VIEW OF TRACK HOPPER MATERIAL BINS AND CONVEYORS. FIG. 3—GENERAL VIEW OF PLANT ON MAY 22, 1922.

The plant is operated as follows: The gravel is dumped from cars into the track hopper and thence elevated to the storage hopper; the sand is clammed from cars or storage, into the track hopper and then elevated. There are four compartments in the storage hopper, one sand

and one gravel for each of the two "T. L. Smith" mixers of 1 1-3 yd capacity. The sand and gravel are drawn from the storage hopper into a measuring bin or hopper directly over each mixer; the cement is brought from the storage shed in bottom dump cars of 9-sack capacity (the cement is received in cloth sacks) operated on a continuous trolley. The cement and sand fill one bin flush and the gravel the other and all is discharged into the mixer simultaneously. The water is automatically controlled at a constant amount and one operator controls both mixers, from the feeding platform.

There is a separate tower for each mixer but the dump hopper of one is connected to the other so that both feed the same line of spouts. The hopper arrangement is plainly shown in Fig. 3, one operator controlling the dumping at the top. One engineer operates both hoists. The round trip of each bucket averages 2 minutes.

The stel reinforcing is furnished by the Sewerage Commission on board cars, but is unloaded and placed by the contractor. The rods are all cut to length and all bends made before the steel is received. A locomotive crane is employed to unload the reinforcing, but after that time it is handled entirely by hand. Fig. 4 is a view of the steel in place for the bottom slab of an aeration tank. Note how perfectly the rods are all placed. There are two mats of steel top and bottom, of 1-in. round rods, supported by spikes driven into the wood piles and by chairs set on top of the piles. Considerable difficulty was experienced at first in supporting the steel mats but this has now all been overcome.

Forms

The original plan was to use steel forms for the entire structure and elaborate changes in the plans were made so that they could be used. Plans were made and the forms all constructed and tried out with the result that wood panel forms have been substituted in nearly every case. The steel forms proved to be very cumbersome and entirely unsuited for the purpose. The only place where the steel forms are being used at present is for the walls of the aeration tanks, and the small drains. Fig. 5 shows the steel forms used for the aeration tank walls as they were being set for the first time. Note the caterpillar crane between the walls used at first in setting the forms. At present the forms are handled by means of two gantry frames; one removes the forms and carries them to the end of the tank, from whence they are picked up by the locomotive crane and carried to the next gantry frame which then picks up and sets the form. On an average, 220 ft. or 11 sections of form are removed and again set, in an 8-hour day.

FIG. 4—VIEW OF BOTTOM SLAB STEEL SET IN SOUTH END OF AERATION TANKS 21-23 AND A PORTION OF SIDE FORMS IN PLACE. FIG. 5—VIEW OF ERECTION OF STEEL FORMS FOR AERATION WALLS.

Fig. 6 shows a completed aeration tank bottom slab with all the wall dowels in place. Fig. 7 shows the same slab, after the vertical wall steel has been wired in place preparatory to setting the wall forms.

Expansion Joints

The entire sewage plant is uniquely divided to take care of expansion and contraction. Three joints extend the entire length of the plant from east to west; one directly on the center line of the plant; one on the south side of the plant at the north edge of the northerly feed channel slab, separating the south aeration units from the south sedimentation units, and the other in a corresponding location on the north side of the plant. There are five joints running north and south, each located on the center line between the adjoining sedimentation tanks. These joints extend through the

concrete from the bottom slab to the top, including all the walls, intermediate slabs, walkways, etc., so that there is a complete division of the structure at each of the joints.

This arrangement of the joints allows each separate settling tank, and each battery of aeration tanks, together with the adjoining channels, to function as a separate and distinct structure as regards expansion and contraction.

The joints are 1½-in. in thickness, being made up of three thicknesses of Carey Elastite Expansion Joint, each ½-in. thick. This Elastite is bolted to a crimped section of 20-gauge copper (in this case furnished by the Atlas Copper Co. of Chicago), being lapped and fitted

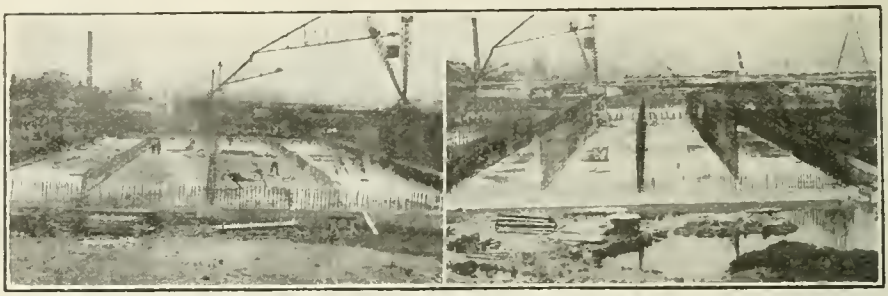


FIG. 6—AERATION TANK 13-15 SHOWING BOTTOM SLAB WITH WALL DOWELS ALL SET TO RECEIVE WALL REINFORCING. AERATION TANK 17-19 SHOWING BOTTOM SLAB WITH WALL STEEL IN POSITION.

so as to make the strongest section. The sections are made up male and female ends so that the copper laps 3 inches when the joint is in position, and the outstanding wings of the copper are then riveted together in the straight sections, and soldered in the special sections. This oustanding wing of copper is anchored into the concrete of the adjoining sections on either side of the expansion joint so that the joint is absolutely watertight.

Special tees, ells and crosses were designed, for use wherever intersections of walls and slabs occurred, so that the expansion joint and also the water seal at each joint would be absolutely continuous. It required considerable ingenuity so to design and construct these specials, so that the expansion could take place in any direction and the joint still remain watertight. The several sections of joints were all made up and bolted together before being carried down to the work.

Discussion of Plant

The plant as designed was calculated to be able to place a maximum of 800 yds. of concrete in 8 hrs., averaging 600 yds. per 8-hour day. The best the equipment has ever done was to place 75 yds. in an hour and 480 yds. in a day's run, considerably over 8 hrs. The material storage is inadequate, no method of handling from storage is provided and the entire plant hinges on the receiving of materials in dump bottom cars, which has at times materially delayed progress and entailed considerable expense in car demurrage. The entire plant is wholly unsuited for the work to be done, lacking in flexibility, capacity and ease of doing the work. The lack of flexibility has been the most serious drawback.

The layout of the work lends itself most admirably to the use of the cableway system, and experience has shown the fallacy of using the spouting method of concreting in this particular plant. Not alone is there concrete to place, and forms to handle, but there is considerable structural steel to be set, pieces weighing upwards of 12 tons, motors to place, thickeners and their mechanisms, sluice gates, gate valves, sludge draw off pipes, large cast iron air mains, diffuser plate containers and separator blocks, brick and stone for the superstructures, the handling of all of which could best be done by means of a cable way. The first cost of a cable way plant for doing all of the work, consisting of two cable ways, was quoted at about $160,000, materially more in first cost than the spouting system, but the difference would have been more than offset in the economy of doing the work.

Summary

There is approximately 65,000 cu. yds. of concrete in the plant, of which about 30,000 yds. wil be in place this season; 5,000 tons of reinforcing steel, of which 60 per cent will be in place, and nearly all of the cast iron pipe for sludge draw will be

in position. Next season will require the completion of all of the concrete work, setting of all gates, valves, pipes, steel work, containers, etc., and the completion of the superstructures. There will be no work carried on during the winter months,

Mr. P. Millard is the general manager in charge of the work for the Du Pont Co. and Mr. McLean the field superintendent. The work is all done under the direction of the Sewerage Commission Engineers, of which T. Chalkley Hatton is chief. George W. Rauch is the division engineer in direct charge of the field work.

PUTTING MUNICIPALLY OWNED WATER PLANTS ON A BUSINESS BASIS

By V. Bernard Siems, Associate Civil Engineer, Water Department, Baltimore, Md.

As a general rule the Water Departments in most cities show a deficit at the end of each year. The primary causes for such losses are: Insufficient rates—water being sold below cost; free water, i. e., water distributed to other municipal departments, such as public schools, hospitals, and other institutions, and for the cleaning of streets and kindred uses, in practically unlimited quantities and without receiving any revenue therefor; and unrestricted water waste, both on the distribution system and from the defective plumbing fixtures of private individuals.

Fair Rates

The determination of a water rate which is fair both to the operators of the water works and to the consumer demands a consideration of many factors. These are briefly suggested: Necessary operating expenses; ample allowance for the maintenance of the system; depreciation charges; interest charges on investment; quantity of free water supplied; and the quantity of water wasted by the consumers. Bearing these outstanding points in mind the consideration of a system of charges may be begun. The basis of any system of charges for service rendered by a public utility should be in conformity with the principles of equity, that is, the charges should be exactly proportionate to the amount of service rendered, and the amount of water service received can only be measured by having a water meter on each water supply service. It is, therefore, advisable that the system be 100% metered.

Front footage water service rates are unjust in that there is absolutely no relationship between the width of the dwelling and the amount of water consumed, and besides an unmetered supply permits of much waste. A rate based upon the number of water fixtures in a building is also an unjust system, as there is no relation between the number of fixtures and the number of occupants. The consumption is dependent, however, upon the number of occupants or the character of business carried on at the property supplied.

State Regulation Advocated

The regulation of privately-owned utilities is now an accomplished fact, and it has unquestionably worked both to the advantage of the utility and the consumer. There can be no sound objection to state regulation of municipally-owned utilities, for if these enterprises are properly and successfully conducted, then everyone interested therein should welcome the opportunity to give the widest publicity to their activities. The hearings and reports of the various Public Service Commissions afford such publicity and embody the experience of men trained to analyze utility operations. It should be a source of gratification to all citizens to know that such a body of experts under the guidance of responsible commissioners are available to consider complaints and to supervise the finances of the municipal enterprise.

The Supreme Court of the United States has ruled in a number of instances that Public Service Commissions have no jurisdiction over the rates of municipally-owned utilities, but it is believed, however, that by special legislative enactment such powers can be granted. This principle is recognized by the state of Wisconsin, and referring to the "Public Service Magazine," issue of January, 1922, we find that the tax commissioners of the state of Wisconsin are to levy an impost on the municipality of Stoughton, which had made itself amenable to state taxation by extending its electric service outside the city limits. Stoughton has applied to the Public Service Commission for permission to increase its rates to meet the tax.

Tax Exemption Misleads

Municipal plants do not pay taxes and therefore their rightful share of taxation is absorbed by the public, and not being subjected to such rigid regulations and supervision as are the privately-owned utilities, taxpayers are sometimes misled

regarding the actual financial situation as any deficit is supplied by additions to the tax rate.

A specific instance will best illustrate the characteristics of a self-supporting, municipally operated public utility and the salient features of the plan advocated are therefore briefly illustrated by applying the suggested measures to the operation of the Baltimore City Water Department.

Baltimore as an Example

The investment in plant and property of the Water Department of Greater Baltimore is estimated to be $35,000,000. By applying a 5% rate of return to this capital investment, the net return would he $1,750,000. It is the general practice, however, of the Public Service Commissions of the country to allow a rate of return of at least 7 per cent to public service corporations. As it is the purpose of a municipally-owned utility to furnish service to the public at cost, the net return of $1,750,000, which is in addition to operating and maintenance costs, wil cover the annual sinking fund and interest on the present water loans, and will create a reserve amount to finance future additions or enlargements to the water system.

The estimated sinking funds and interest payments are considered to be constant for the duration of the loan. The accumulative reserve amount, in the intervals between its use by the Water Department for financing extensions, could be used by the City Comptroller for temporary financing, and would obviate any short time borrowing by the city. In order that the necessary increase of this sum would not be interrupted, however, it would be necessary that the market rate of interest be paid on such loans.

The annual depreciation covers the cost of renewing the parts of the impounding, purification, pumpage and distribution works which have deteriorated or have been damaged by use; $350,000, or 1 per cent of the value of the plant being so charged.

By adding together the fair net return of $1,750,000, or 5 per cent on the approximate investment in the present plant and the private water companies, and an annual depreciation of $350,000, or 1 per cent on the assumed valuation, together with the operating expenses, aggregating $1,715,000, of the present department and private water companies, $3,815,000 is obtained as the total service revenue required to make the enlarged Water Department self-sustaining. Having determined the total service revenue required, the necessary allocation can be made so that the charges will be equitably distributed and in direct proportion to the cost of delivering water to the respective consumers.

The total service revenue may be divided into that received from public fire protection and that derived from general water service. The amount to be charged to public fire protection is determined by multiplying the total number of fire hydrants in the city by a unit charge of $40, the result—$192,000—being 5 per cent of the total service revenue. The amount of water that must be potentially available for fire protection increases enormously the capital expenditure on a water distribution system. The general tax levy is the proper source from which the entire cost of public fire protection should be received, as it is then paid in proportion to the value of the property protected.

By deducting the public fire protection revenue from the total revenue the general water service revenue, aggregating $3,623,000, is obtained. This sum, which includes the revenue to be received from private fire protection services, is the amount received from the water consumer. In order that the water service rates may be in direct proportion to the cost of furnishing water to each consumer, the general water service revenue is subdivided into the amount to be received from the fixed service charge and that to be received from the consumption charge. By taking 40 per cent of the general water service revenue, the fixed service charge of $1,449,200 is obtained.

The fixed charge covers the cost of service, and does not vary as the amount of water consumed, but is a constant charge comprising two elements of cost: namely, the capacity or readiness to serve cost, and the consumer's cost. The capacity or readiness to serve cost is the cost of labor, material and interest appurtenant to that part of the plant which is idle when the normal demand exists, but which is held in readiness to supply the maximum demand. The Consumer's charge covers the cost of reading meters, etc., and varies but little. This charge of $362,300 is obtained by deducting the readiness to serve cost from the fixed service cost. The sum of $2,173,800 to be received from the consumption charge, is obtained by deducting the fixed service

revenue from the general water service revenue.

Having obtained the proper allocation of the revenue, the water service rates, consisting of a fixed service charge and a consumption charge, can be determined. As previously stated, the fixed service charge comprises the capacity or readiness to serve charge and the consumer's charge. In order that the capacity charge may be proportional to the maximum capacity of the different sized meters, ratios were ascertained by taking the flow of a ⅝-inch meter as unity and determining the ratios of larger meters thereby. By dividing the capacity or readiness to serve charge revenue by the total number of units, the yearly unit capacity charge of $4.30 per meter is obtained. The consumer's charge revenue divided by the total number of services gives a yearly consumer's charge of $2.35 per meter. The yearly fixed service charge, that is, the yearly unit capacity charge of $4.30 and the yearly consumer's charge of $2.35 therefore varies from $6.65 for a ⅝-in. meter to over $1,400 for a 12-in. meter. This fixed service rate is chargeable whether the consumer has used water or not, as the water plant must be held in readiness at all times to deliver his maximum demand.

The next step in devising the schedule of rates is to determine the rate per unit of water to be assessed in addition to the fixed service charge. By deducting the fixed service charge revenue from the general water service revenue, the water service revenue of $2,173,190.75 is obtained, and considering a revenue bearing water consumption of over three billion cubic feet per year the average water service rate would be 70 cents per 1,000 cu. feet. At the cost per unit decreases as the demand increases, a sliding scale of rates has been devised, allowing four classes of consumption and varying from 80 cents per 1,000 cu. feet, for small consumers, to 28 cents for those using five million cu. feet per year. Domestic services are to be charged a minimum fixed meter service rate of $12.50, allowing a yearly consumption of 7,300 cu. feet based upon the use of 30 gallons per capita per day for an average family, any excess thereover to be charged for at the sliding scale rate. The majority of the smaller residential properties will come under this class.

The preceding schedule of water rates is just, reasonable, and not discriminatory; and devised to meet conditions which must be provided for in any efficiently managed utility. It cannot be argued that rates are excessive which provide revenue only sufficient to take care of operating and maintenance expenses, sinking funds, interest on the various bond issues, and a small surplus to be used for any necessary extensions. Of the amount designated as a fair net return any excess over interest charges is to be applied to the retiring of the existing bond issues, and to the creation of a surplus for the financing of any future additions or improvements.

While the subject of bond issues is touched upon, it may be said that it is unwise to extend the term of bonds over a greater number of years than the effective life of the work which they are to finance, as the direct benefit of the improvements is secured by the present generation, although the usual loans extend over such a long period of time that the following generation is still taxed without receiving any proportionate benefit. This opinion is also expressed by that portion of the Constitution of Maryland which reads that "no debt shall be hereafter contracted by the General Assembly unless such debt shall be authorized by a law providing for the collection of an annual tax or taxes sufficient to pay the interest on such debt as it falls due, and also to discharge the principal thereof within 15 years from the time of contracting same * * *"

The foregoing discussion has dealt exclusively with the financial operation of a water department. The essential difference between such a department and other municipal operations must next be considered and such distinctions judged from the viewpoint of the advisability of their operations as self-supporting financial units.

Still continuing to apply our reasoning with the city of Baltimore as an example the various municipal activities apart from the sale of water must be considered. Second in importance to a supply of potable water is an efficient system for the disposal of waste, that is, the Sewer Division. Any charge levied on the individual consumer to make this department self-supporting would partake in general of the characteristics of a flat rate. If a flat rate is to be levied, a far more convenient method of payment would be by including this charge in the tax rate proper, which is, in fact, the present method of supporting the sewerage system. As there is, however, a direct and

unvarying relation between the amount of water consumed on each premise and the amount of waste water issuing therefrom, a revenue bearing system for sewerage service could be constructed, based upon the metered consumption of the property. This carries us back to one of the first statements made in this paper—it is absolutely essential that a city be 100 per cent metered.

The disposal of garbage and ashes is another municipal function. As it would not be feasible to weigh or otherwise make a definite unit charge for each cu. foot of matter removed, a flat rate charge would again have to be assessed, and the general tax levy is the proper place for such charges to be made. The Street Cleaning Department—responsible for the cleanliness of all thoroughfares—is another city unit which serves every citizen, but the individual property owner cannot be expected to pay for the benefit derived according to the front footage of his property. The expenses of this department should, therefore, be taken from the general tax levy. The maintenance of the municipal hospital and almshouses indirectly benefits each and every citizen, but as the patient is rendered free attention the charge must be distributed over the entire population, that is, taken from the tax rate. The various activities of the Health Department also fall within this category. By this elimination of all other municipal activities the Water Department stands forth alone as an organization capable of being made into an efficient self-supporting organization, selling service at cost to all citizens who are, moreover, not merely consumers and therefore revenue producers, but as citizens of the municipality, also owners of the plant itself.

One of the foremost authorities on water works known for the keenness of his reasoning—I refer to Mr. Nicholas S. Hill, Jr., of New York City—has given much consideration to the efficient management of municipally-owned water works and as chairman of a committee, delivered a report on water works and water supply at the 1921 convention of the American Society for Municipal Improvements. Mr. Hill gave a resume of the characteristic features of a great majority of municipally-owned water works and then gave a frank discussion of the essential weaknesses of these organizations and the imperative need of radical changes. Such topics as personnel—the questionable practice of employing mediocre engineers on insufficient salaries; the absolute absence of justly apportioned water rates; the practice of meeting deficits by appropriations taken from the tax levy and the need of an adequate accounting system and a uniform scheme of reports were all touched upon in some detail. Such subjects as the standardization of materials and equipment, the efficiency of various types of machinery, the need of adequate rainfall and run-off records, the design of works for the collection and distribution of water, standards for water quality, the need of water softening and water purification, and the relation of the water supply and various diseases were also discussed.

What I especially wished to bring to your attention, however, is the following quotation from his paper:

"There is no aspect of the problem of water works management and maintenance which has been given so little attention on the part of municipal officials as the economic aspect of the problem, and there is a great opportunity in this country for placing municipally-owned water works on a sound financial basis by the establishment of rate structures which will not only provide the money necessary for their maintenance and operation but which will not unjustly and unfairly discriminate betwen different classes of consumers."

The above paragraph states an idea worthy of the deepest consideration.

The preceding paper, recently presented before the Four States Section of the American Water Works Association, was suggested by some of the ideas embodied in reports entitled, "Investigation of the Water Supply Improvements for Greater Baltimore" and "Recommended Schedule of Rates for the Water Department of the City of Baltimore," which were submitted by the writer to the Water Engineer.

FOOTPATHS PROPOSED FOR NEW JERSEY ROADS

Good roads enthusiasts will present to the next session of the New Jersey legislature a bill providing for the construction of footpaths along the state highways. New Jersey has hundreds of miles of beautful tree-lined asphalt roads and the State Highway Commission is favorable to the footpath idea, believing that the paths will keep pedestrians off the roadway and thereby greatly reduce highway

accidents. An attempt will be made with the support of the State Highway Commision to amend the state highway act with the following provision: "Proper footpaths for the use of pedestrians may be constructed on such portions of any state highway where, in the opinion of the State Highway Commision, such construction is necessary or advisable."

COST OF BUILDING FLOW PARTITION WALLS IN IMHOFF TANKS BY CEMENT GUN METHOD

By George B. Gascoigne, Consulting Engineer, Leader-News Bldg., Cleveland, O.

One of the items in the construction of the Westerly Sewage Treatment Works, city of Cleveland, called for the building of 9,500 sq. yds. of flow partition walls in the two-story settling tanks. These partitions separate the flow compartments and gas vents, and as usually built require much form work and difficulty in placing concrete due to the thin sections involved. As this is the first instance, to the writer's knowledge, of the use of the cement gun in building flow partitions 3 ins. thick, the methods used and cost data should be of interest.

Description of Work

The Westerly Sewage Treatment Works included, as part of the scheme of treatment, 16 settling tanks. Fig. No. 1 shows a cross section of one of these units, and Fig. 2 a longitudinal section. As will be seen, the tanks which are 50 ft. long, are each divided into four flow compartments by means of 8 partition walls. The area of partitions is 580 sq. yds. per tank, or 9,280 sq. yds. total, to which an addition must be made for wastage in ends and corners. The upper portions of the partition walls, to a point 2 ft. below the flow line, were built of formed reinforced concrete, but below this point gunite was used. The net thickness of the gunite partition was 3 ins., built up of four coats of cement mortar on metal lath. The span center to center of supporting cross walls was 9 ft. As horizontal reinforcement No. 24 gauge" Self-Sentering" metal lath was used, which gave a computed load-carrying capacity of 100 lbs. per sq. ft., amply sufficient in view of the facts that this partition carries practically no load, and that the water pressures on the two sides always balance each other.

Details of Construction

Fig. 3 shows the details of construction. The metal lath was placed with the ribs running horizontally and attached to ⅜-in. dowels set in the cross walls 12 ins. apart, the projecting ends of which were bent down over a ½-in. rod to hold the lath in place. To increase the stiffness and continuity a system of No. 4 gauge wires placed diagonally 18 ins. on center

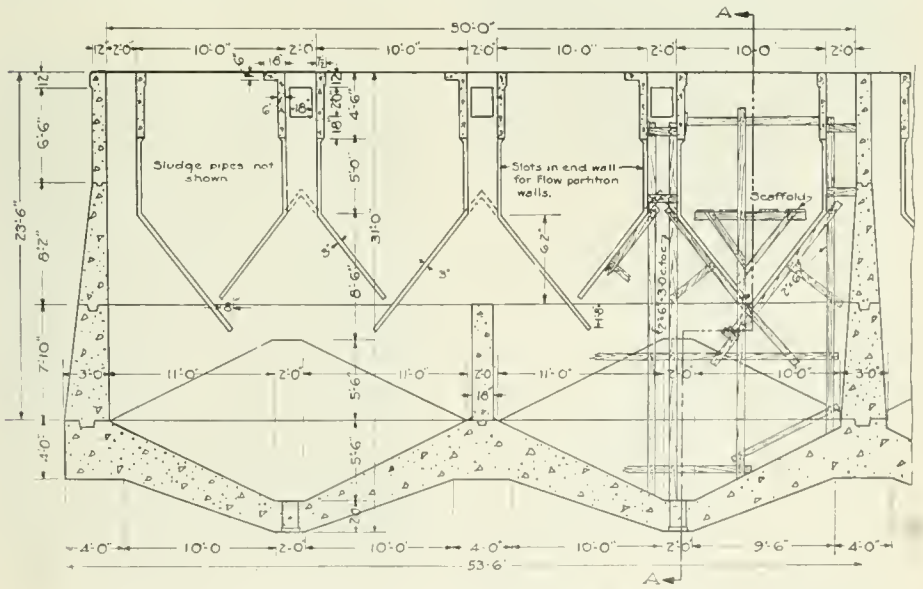


FIG. 1—TRANSVERSE SECTION THROUGH ONE IMHOFF SETTLING TANK, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

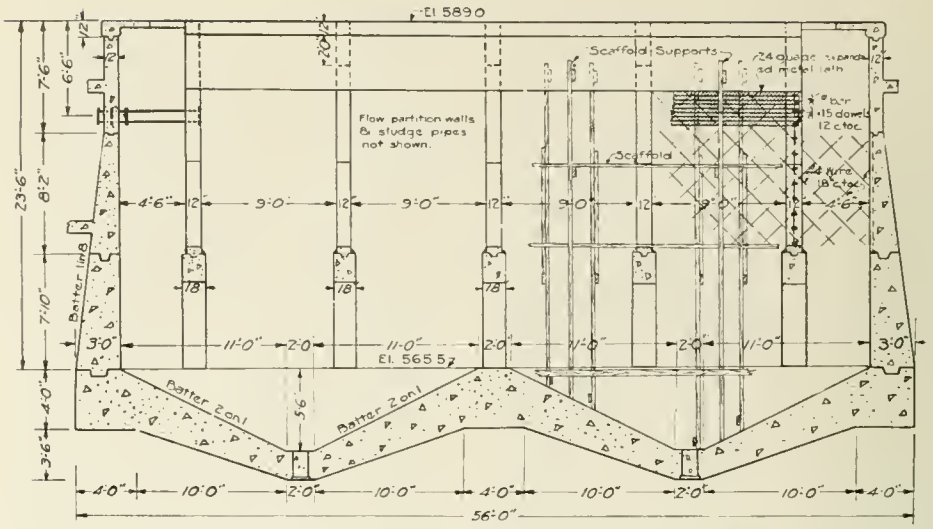


FIG. 2—LONGITUDINAL SECTION THROUGH ONE IMHOFF SETTLING TANK, WESTERLY SEWAGE TREAMENT WORKS, CLEVELAND, OHIO.

in both directions was fastened to the back of the metal lath. Adjoining sections of lath were lapped 10 ins. on ends, and the ribs interlocked lengthwise and all intersections were well wired.

This made a very stiff structure, and the only additional support needed to hold the green walls in place while setting or being concreted consisted of bents of 2 by 6's placed 3 ft. apart; that is, two in each span, which at the same time served to support the scaffolding for the workers. Along the lower edge of the sloping partition a curb board was placed, but no other forms were necessary, the metal lath serving to retain the mortar in place until it had set.

No. 24 gauge "Self-Sentering" metal lath, made by the General Fireproofing Company, Youngstown, O., was used. This weighs 3.4 lbs. per sq. ft. and comes in sections 29 ins. wide and 11 ft. long. The ends were lapped 10 ins., and in adjoining sections the outside ribs were interlocked. This, combined with the irregular fitting necessary at ends of tanks and cutting along bottom of parti-

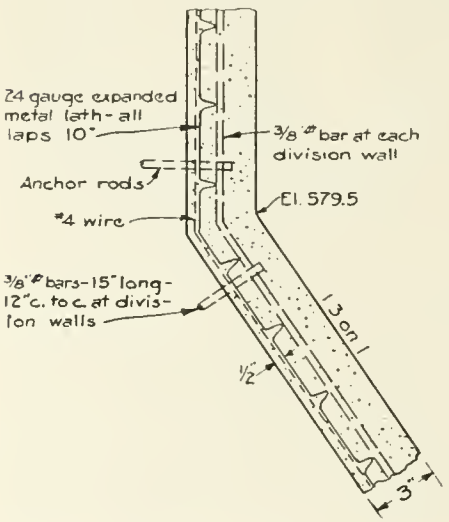
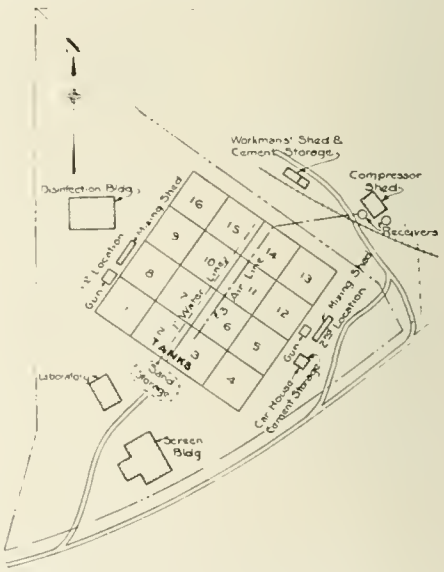

24 gauge expanded metal lath - all laps 10"
3/8" ϕ bar at each division wall
Anchor rods
El. 579.5
#4 wire
3/8" ϕ bars - 15" long - 12" c. to c. at division walls
1 3 on 1
1/2"
3"

FIG. 3—DETAIL OF PARTITION WALL.



FIGI. 4—LAYOUT OF CONTRACTOR'S PLANT.

FIG. 5—PLACING METAL LATH.

tions, required an excess area of 22 per cent.

Specifications called for 1 to 2 mortar tempered with 1 part of lime to 10 parts mortar. Actually, Palace Island sand and Universal cement was used, without lime, except in the case of the scratch coat, where 10 per cent of lime and a small amount of hair was added.

Description of Plant

The equipment used consisted of two No. 2 Cement Guns, manufactured by the Cement Gun Company at Allentown, Pa. No. 2 gun is the largest size manufacturned by this Company, and is capable of "shooting" 150 bags of cement per day

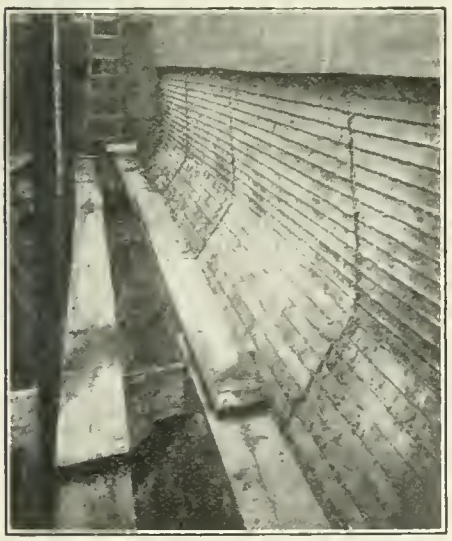


FIG. 6—SCRATCH COAT ON FLOW PARTITION.

(using the mix used at West 58th St.) This amount is equivalent to approximately 350 cu. ft. of mixed materials ready to be applied at the nozzle.

Two compressors were used to supply air to the guns. One compressor was a Chicago Pneumatic Company, 10x12, and the other an Ingersoll Rand, 8x10. The Chicago Pneumatic was belt connected to a 50 h. p. G. E. motor, having the following rating: 3 phase, 60 cycle, 220 volt, 124 A, 865 R. P. M. The Ingersoll Rand was belt connected to a 50 h. p. Crocker Wheeler motor, having the following rating: 3 phase, 60 cycle, 220 volt, 125 A,

FIG. 7—APPEARANCE OF FINISHED PARTITION WALL.

860 R. P. M. Two tanks approximately 3 ft. in diameter and 7 ft. high were used as air receivers. The main air line was 3 ins. diameter, W. I. pipe from which smaller lines to the guns were taken. The remainder of the equipment consisted in sheds for storage of tools and materials, scaffolding and forming lumber, covers for tanks and small tools. The compressors furnished air at 75 to 80 lbs. at the compressor, which gave about 35 to 45 lbs. at the nozzle.

The first set-up was as shown in Fig. 4 near the disinfection building. The sand was stored east of the laboratory and wheeled to the mixing shed. The

sand was not covered at all times and on several occasions became too wet for mixing. The major portion of tanks 1, 8, 9, 16, 2, 7 and 10 were gunned from this position. When work was reopened in 1922 the first gun was moved to the top of tank No. 6, and a second gun was placed south of tank No. 12, a mixing shed being built east of the car house, where the cement was stored, the sand being stored close at hand. After the third row of tanks was well along, the first gun was moved south of tank No. 12, and operated at this location until the work was completed.

Progress of Work

Work was begun about September 1, 1921, in tank No. 1 and continued till the middle of December. It was again started about the middle of May, 1922, and completed the end of July, 1922, or a total of six months.

Method of Operation

Work was begun about Sept. 1st, 1921, intank No. 1 and continued till the middle of December. It was again started about the middle of May, 1922, and completed the end of July, 1922, or a total of six months.

The cement was stored in weatherproof sheds, and the sand was stored in the open during most of the time. The sand was measured and mixed thoroughly with the cement and screened through a ¼ in. mesh screen before it was taken to the gun. The mixing was done "dry" —meaning that no water was added during mixing and the mix contained only moisture that was in the sand as it came to the job. During the progress of the work a quantity of sand was kiln dried and mixed with cement at the plant of the Cleveland Builders' Supply Company. This material was absolutely dry and could be machine mixed and stored in large quantities, thus saving the labor cost of hand mixing. This material was an absolute failure for use in the guns at the West 58th St. Plant—no satisfactory explanation why it did not work could be given. The mix was shoveled directly into the hopper of the gun and carried through the gun and hose with air at 35 lb. pressure. The application of water to the mixture was done at the nozzle, and the entire mixing was accomplished in a distance of 6 or 7 ins.

The scratch coat was troweled on and made just thick enough to fill the openings in the metal lath and thus form a backing for the gunite, as well as a key for the back coat. Twenty-four hours later the first gun coat was shot on, followed 24 hours later by the second gun coat, which served principally to even up the surface and was only ½ to ¾ ins. thick. Immediately after the second gun the wall was finished by screeding and floating to a smooth, even surface. After the wall had stood seven days, the forms were removed and the back finished, the upper portion by hand and the lower portion by gun. The back gun coat was not troweled. The clean-up consisted mostly in removing rebound materials from the bottom of the tanks. This was quite large in amount and was first removed in buckets, but later small hoists driven by gasoline engines were used.

Operating Force

The operating force consisted chiefly of a superintendent, who gave only part time to the work; a plaster foreman, who acted as superintendent when the other man was off the job; a lather foreman, engineer, plasterers, lathers and laborers.

The number of men varied considerably throughout the period of doing the work, but the following list of men is the average number to carry on the work when one or two guns are operated:

	One Gun	Two Guns
Superintendent	1	1
Lather Foreman	1	1
Plasterer Foreman and Asst. Supt.	1	1
Plasterers	3	6
Engineers (Compressors)	1	1
Nozzle Man	1	2
Nozzle Man Helper	1	2
Laborers (Building Scaffold)	2	3
Gun Man	1	2
Gun Man Helper	1	1
Laborers Mixing Material	2	3
Laborers Wheeling Sand and Cement	1	1
Laborers Cleaning	3	4
Engineer (Cleaning)	1	1
	23	35

Cost of Work

With excess area the job called for 12,000 sq. yds. of metal lath, and 10 tons pencil wiring and miscellaneous steel. The contractor's unit price on this was 77 cts. per sq. yd.

The net amount of mortar reqqired was 770 cu. yds. In this connection it should be noted that by actual test the cement gun method required 28.5 per cent excess material, due to rebounding, wastage, etc., as against 8.5 per cent estimated for

hand troweling, which is also reflected in the labor item for cleaning up. The cost figure on this came to $1.11 per sq. yd.

Lumber for scaffolding and forms, based on 6 reuses, amounted to 26 cts. per sq. yd.

The labor costs were kept in detail for each kind of work in each tank and are shown in detail by Table 1, together with average labor costs for the whole job. As the contractor was inexperienced in the use of the cement gun method, the cost on the first tanks done was naturally higher than that of later work. This was particularly due to improper apportionment of the different classes of common and skilled labor on the work, and the lack of judgment shown in placing materials and equipment, matters which were later corrected.

The cost of electric power for operating compressors and miscellaneous uses was about $1,200 for the job, or 12.5 cts. per sq. yd.

The guns were rented, as was also the compresser plant. Other equipment charges were hose renewal, gun repair and motor and compressor supplies. These were on a yardage basis:

	Per Sq. Yd.
Gun Rental	$0.101
Compressor Rental	0.170
Gun Repair	0.013
Supplies and Misc.	0.500
	$5.294

The summarized cost per square yard from above sources is as follows:

	Per Sq. Yd.
Metal Lath	$0.770
Mortar	1.110
Scaffolding	0.260
Labor	2,345
Power	0.125
Equipment Charge	0.784
Total	$0.784

The unit wages paid upon the work were, for common labor, 58 to 70c per hour, while lathers, finishers and plasterers received $1.10 per hour. Common labor was used to place the scaffolding.

The total amount paid the contractor was approximately $70,000, which means he received about $7.36 per sq. yd. Carefully detailed cost records were kept by the city from which the data of this article were obtained. They show that the cost, exclusive of overhead charges and contractor's profit, was approximately $5.30.

Summary

We found a number of unlooked for conditions and unusual factors in this work. For one thing, obtaining the use of the cement guns in the number and at the time required, and at what seemed a fair rental value to the contractor appeared to be a matter of some difficulty, although it would seem that the makers of this equipment should be interested in extending and popularizing this method

TABLE I—SHOWING COST OF LABOR PER SQ. YD. OF FLOW PARTITION WALLS WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

Tank	Scaffolding.	Lathing	Scratch	1st Gun	2nd Gun	Finish	Back Top	Back Bottom	Cleaning	Wrecking	Mixing	Total
1.....	1.180	0.845	0.094	0.177	0.126	0.114	0.258	0.180	0.222	0.065	0.8225	4.0835
2.....	0.093	0.280	0.119	0.151	0.115	0.110	0.365	0.219	0.310	0.070	0.499	2.331
3.....	0.105	0.366	0.214	0.168	0.080	0.131	0.084	0.114	0.345	0.061	0.405	2.073
4.....	0.142	0.400	0.096	0.150	0.099	0.110	0.090	0.084	0.292	0.064	0.387	1.914
5.....	0.156	0.360	0.095	0.140	0.096	0.105	0.119	0.182	0.326	0.050	0.409	2.038
6.....	0.182	0.399	0.116	0.126	0.092	0.140	0.164	0.190	0.338	0.062	0.369	2.178
7.....	0.227	0.405	0.111	0.161	0.123	0.094	0.299	0.238	0.260	0.069	0.283	2.270
8.....	0.354	0.540	0.109	0.196	0.115	0.111	0.340	0.205	0.209	0.055	0.319	2.553
9.....	0.315	0.405	0.130	0.152	0.118	0.102	0.287	0.223	0.297	0.055	0.282	2.366
10.....	0.238	0.490	0.110	0.162	0.124	0.108	0.190	0.103	0.426	0.100	0.435	2.486
11.....	0.114	0.365	0.100	0.118	0.085	0.131	0.175	0.155	0.314	0.045	0.406	2.008
12.....	0.183	0.396	0.100	0.150	0.090	0.084	0.110	0.254	0.328	0.067	0.387	2.149
13.....	0.207	0.360	0.108	0.124	0.132	0.111	0.124	0.120	0.375	0.057	0.425	2.143
14.....	0.299	0.340	0.086	0.122	0.100	0.121	0.136	0.105	0.323	0.070	0.396	2.098
15.....	0.270	0.414	0.105	0.170	0.095	0.105	0.131	0.124	0.392	....	0.379	2.185
16.....	0.370	0.440	0.148	0.184	0.124	0.120	0.257	0.237	0.300	0.066	0.424	2.670
Average	0.277	0.425	0.115	0.153	0.107	0.112	0.196	0.171	0.316	0.064	0.414	2.345
% of Total	11.7	18.1	4.9	6.5	4 6	4.8	8.3	7.3	13.5	2.7	17.6	100

of concreting. The plasterers by trade do not look with favor on this system, as being in competition with the long established trowel method, and it is difficult to secure their full co-operation on the work. We were much impressed with the necessity of having the gun work done by experienced men, and having the job properly supervised by some one who specialized in this line. An item not generally considered is the large waste of mortar. As pointed out herein, this amounted to over 28 per cent, as compared with about 8 per cent by the usual trowel method.

This work was done under the general supervision of Mr. Robert Hoffman, Commissioner and Chief Engineer, and immediate direction of J. Milton Heffelfinger, Resident Engineer, by the Bagnall-Taylor Company, as sub-contractors for the Masters & Mullen Construction Company of Cleveland, general contractors.

ECONOMICAL CONTROL OF CHEMICAL DOSAGE IN WATER FILTRATION PLANTS

By R. A. Maddock, in Charge of Water Purification, Room 6 City Hall, Charlotte, N. C.

One of the greatest opportunities to reduce operating expenses of water purification plants is in the control of chemical dosage. The point of application, agitation and hydrogen-ion concentration, all have an important bearing on economical coagulation and sedimentation, over which the operator usually has control. By careful and intelligent handling the hydrogen-ion concentration can be adjusted to the optimum pH value, which is necessary for complete, or nearly complete, precipitation of the aluminum from the alum added to the water, which means less chemicals will be required for a given bacteria, turbidity or color removal. This point has not been very definitely established as yet, and the reports from various sections would indicate that it varies for different waters.

Very often the chemicals are introduced into the main just before reaching the sedimentation basin, and while this method is satisfactory under most conditions, it will at times be found an advantage to apply the chemicals at some other point or at several points. If the water to be treated contains much heavy sediment, it would be a waste of money to apply the chemicals before the water enters the basin, since a large portion would be carried down with the heavy particles soon after entering the basin. Under conditions of this kind it would often be found advantageous to let the heavy particles settle out in the first part of the basin without the aid of coagulation, and apply the chemicals at or near the center of the basin if capacity will permit.

We know that the temperature of all surface waters fluctuates and that temperature has a marked effect upon coagulation, which is another reason that provisions should be made to apply the chemicals at different points. The proper time to install provisions of this kind is when the plant is built, but, with all kind feelings, I am prompted to say that we have many designing engineers who are unfamiliar with plant operation. On a great many occasions the credit for a plant that is operated with apparently good results has gone to the engineer when it rightfully belonged to the plant operator.

In many plants it is necessary to use quicklime (calcium oxide) in connection with sulphate of alumina. To get the best results from its use it should be slacked very carefully. Hot water will be found best for this purpose, as the temperature during slacking should be as high as possible.

A method is being installed in the new water treatment plant at Newark, O., which was designed by Charles P. Hoover, assisted by A. R. Holbrook, which consists of excess treatment with lime, soda ash and alum, combined. This excess treatment will be obtained by overdosing a portion of the supply and subsequently mixing it with a larger and untreated part of the supply. The amount to be treated with excess amount of chemicals will be approximately 25 per cent, immediately after which it will be vigorously agitated for about five minutes. This 25 per cent portion will then be mixed with the 75 per cent untreated portion in a baffled mixing tank, through which the water will have a carrying velocity of 0.4 ft. per second, the detention period being 60 minutes. The entire body of water will then be passed to concentrating tanks equipped with Dorr thickeners, where the water will remain for about 22 minutes. It is pointed out by Mr. Hoover that the extraction of as much as possible of the precipitate or sludge in the thickeners before the water passes to the sedimentation basin will lessen the accumulation of sludge at the entrance of the basin and

thus make the basin utilizable to its full capacity at all times. It is believed that this method will prove to be economical as well as efficient.

While the carbonation of water as an aid to coagulation is more or less in the experimental state, it has been reported on very favorably.

John R. Baylis, Principal Sanitary Chemist, water department, Baltimore, Md., has recently reported that at Baltimore the addition of a small amount of sulphuric acid to the water before, or at the same time as the alum, has aided coagulation very materially. He reports that several trials have been made under operating conditions, with results that show considerable saving in alum. From this experimental work Mr. Baylis draws the conclusion that in most places an acid alum could be used with better results than basic alum, which is being used almost universally.

The waters in some lakes and a few rivers, especially at certain seasons of the year, are comparatively free from coloring and suspended matter, and could be treated very successfully, the writer believes, with a method he used at Oshkosh, Wis., for about two years, and which resulted in a large saving of chemicals. Oshkosh gets its water supply from Lake Winnebago, which during several months of the year has little coloring or suspended matter. The method used during these favorable periods is described as follows: "Discontinue the application of chemicals to the sedimentation basin and instead apply a strong solution of sulphate of alumina to the quiescent water in a freshly washed filter bed and allow to stand long enough to break up and form a mat of aluminum hydroxide of a uniform thickness. Some will remember a few years ago when asbestos was tried out to produce a filtering mat on the surface of the sand, but was a failure, due to inability to get a uniform thickness. The amount of sulphate of alumina used depends upon the strength of the solution as well as the area of the sand bed. This solution can be applied through an ordinary garden hose, but was applied at Oshkosh through perforated pipes placed over the filters at regular intervals. This method does away with any chance to get alum in the filter effluent, and provides a good mat from the very beginning of each filter run. The writer believes this method could be successfully used at a great many plants—at least periodically.

It has been observed at some few places that chlorination preceding the addition of alum has very greatly aided coagulation in removing both suspended and coloring matter. The application of chlorine prior to filtration is, the writer believes, in many instances good practice, since where bacterial removal alone is sought by the use of alum, to produce an effluent from the filters that will compare favorably to the American Public Health Standard, the substitution of chlorine for alum will be found an effective substitute.

Should a plant operator be classed as careless or incapable because he does not strive to produce a low bacterial count in the effluent from the filters, but who regulates his chemical dosage so as to get a water that is free from suspended matter and depend on chlorination for satisfactory bacterial count? In a great many cases the answer to this question should be "no." Many of those who favor treating the water with sufficient chemicals so as to obtain an effluent that will pass the United States Health Standard before chlorination, seem to think that it is unsafe to rely upon chlorine to do its full and just share. This is probably true for the plant that is inefficiently operated and that relies on one chlorinating outfit. All plants should have two complete chlorinating units with a supply of all extra parts on hand so in case one machine goes down and out there need be no delay or interruption in the sterilization of the water. In the larger plants both chlorinators should be allowed to run with the dose divided equally between them.

Proper installation of chlorinators operated in multiple units is all that some of our larger cities depend on for the successful purification of their water supply. Of course chlorinators require intelligent supervision the same as any other mechanical device.

Some few engineers go so far as to contend that chlorine should not be used at all. From the standpoint of economy it seems to me that it is poor business as well as poor judgment to spend four dollars to purify a million gallons of water without the use of chlorine when the same standard of purity can be maintained for two dollars by using chlorine in connection with coagulation and filtration. On the other hand, to insure a constant supply of pure water, depending at all times entirely on coagulation and filtration, would in most cases require a trained man on the job every hour of the day and

night, which is a condition found only in our largest cities.

In a number of cases chlorination has enabled the rate of filtration to be increased. This increased capacity, which otherwise would have called for additional filter units, has been obtained without any further costs. It is constantly being demonstrated that it is possible successfully to operate water purification plants and to obtain the desired clarification and color removal by the use of alum, and rely on chlorination for bacterial removal.

The writer believes that using chlorine on the side of safety is the proper thing to do when treating such waters as those that show a satisfactory bacterial count when treated to produce 100 per cent clarification and a satisfactory color removal. However, I believe that in limiting the use of chlorine only as a measure on the side of safety, we are not making proper use of the greatest instrument ever placed in the hands of water purification engineers.

We plant operators are too often inclined to accept the other fellow's word for it that a certain thing will or will not work. The writer believes this in many cases to be decidedly wrong since the conditions under which the other fellow is working may be entirely different from our own. At Charlotte we have been able to reduce operating expenses about $6,500 per year.

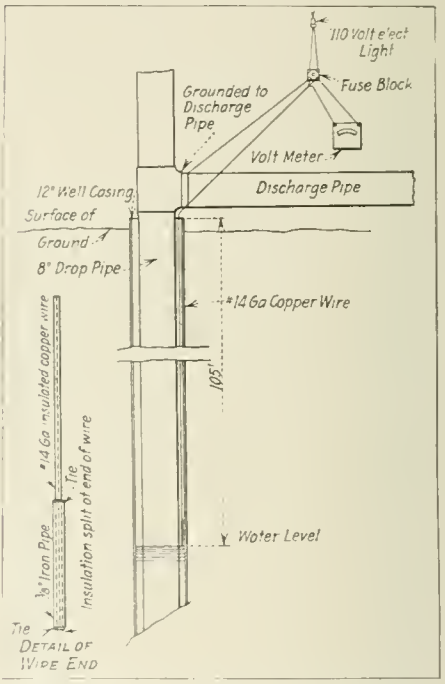
The foregoing matter is from a paper by Mr. Maddock before the recent meeting of the North Carolina section of the American Water Works Association.

METHOD OF MEASURING DEPTH OF WATER IN WELL

By Jent G. Thorne, Consulting Engineer, 317 Howe's Block, Clinton, Iowa.

During the testing of the new deep well recently drilled in Dewitt, Iowa, the height of the water in the well, both before pumping and while pumping, was measured by means of an electric current.

A No. 14 gauge, rubber-insulated copper wire was fitted on one end with a ⅜-in. iron pipe 2 ft. long, to act as a weight, securely tied to the wire. The wire was cut off about an inch below the end of this pipe and the insulation was allowed to extend slightly below the end of the copper wire. The other end of this wire was connected to one terminal of a fuse block, while another wire was run to the second terminal on the fuse block and grounded on the iron drop pipe. From the third and fourth terminals of the fuse block a connection was made to the 110 volt city electric current. A volt meter was connected to the first two terminals of the fuse block to indicate when the circuit was made. While the wire was being lowered into the well the hand on the volt meter stood at zero until the water was reached, when it would move up four or five points. By working the wire up and down several times the exact



SKETCH SHOWING APPARATUS USED TO DETERMINE ELEVATION OF WATER IN DEEP WELLS.

point was indicated where the hand on the volt meter would commence to move. In this way the exact height of the water in the well was measured very quickly. A string with a wooden float was used, but was not successful on account of the scarcity of room between the drop pipe and the well casing. An electric bulb was tried instead of the volt meter, but did not give results. The whole apparatus is very simple and easy to install, and gives the results desired without question of their being correct.

RELINING STEEL COAL HOPPERS AND BUNKERS WITH GUNITE

By James G. Melluish, Consulting Engineer, 222 Unity Bldg., Bloomington, Ind.

The power plant of the Bloomington & Normal Railway & Light Company, is located in the city of Bloomington, Ill., adjoining the right-of-way of the C. C., C. & St. L. R. R., between Madison ntreet and ter tube boilers is stoked by a complete Roosevelt avenue. Its battery of ten walayout of automatic stokers. Some months ago the steel coal hopper and overhead coal bunkers became corroded and eaten through by the action of the sulphuric acid from the soft coal used in this plant.

After considering the cost of repairing by means of relining with steel the bunkers and hoppers, or of entirely renewing them, it was determined to adopt a dlfferent method, namely, of relining the bunkers and hoppers with reinforced concrete. The work was started on Jan. 10, 1922, and finished on Feb. 21, 1922. The operation of the plant was continuous throughout this period and no interruption or inconvenience was occasioned, and one of the determining factors in adopting this method was the expectation that no interruption of the plant would be occasioned.

The contract for the work was taken by the Cement-Gun Construction Company of Chicago, Ill., under the supervision of D. G. Walace, Operating Engineer for the Bloomington & Normal Railway & Light Company. For the construction company Mr. Frank Beeby, its Chief Engineer, designed the reinforcement and made inspections.

The method of reconstruction and lining was as follows: Cast iron bin gates were made and installed, and also a reinforcing plate 18 ins by ¼ in. steel put around the bottom of each bunker. A large number of rivets were found to be burned out of the bunkers, and bolts were therefore extended through into the concrete, as well as being fastened to the stiffening beams on the outside of the bunker.

The hopper on the outside of the building was reinforced with American Steel & Wire Company's reinforcement No. 0.049 and with ⅜-in. sq. rods. The bunkers on the inside of the building were likewise reinforced.

The concrete beam was extended across between bunkers, and also the beam effect on the sides, in order to relieve the strain on the old bunker sheet and practically take all of the weight indirectly off the concrete lining.

The concrete lining varies in thickness from 1½ in. to 2½ Ins. on the general covering and increases at the beam points to 4 ins. to 6 ins. The steel work was very carefully bent, and also the steel plates were thoroughly cleaned off with sand blast before being covered with cement. All steel supports and bunker columns were thoroughly inspected and cleaned off In order that the concrete beams would have a rigid bearing on the vertical steel supporting columns.

RELINING COAL HOPPER WITH REINFORCED CONCRETE BY CEMENT GUN PROCESS AT BLOOMINGTON, ILL.

The concrete mixture for this reconstruction was 3½ to 1. Lincoln (Illinois) Sand and Gravel Company special washed, cleaned, dry torpedo sand was used and Alpha Portland cement. The cement was applied with cement-gun, under pressure of approximately 55 lbs., as shown in the accompanying view, where deposition of concrete through the gun nozzle is shown in its application to the coal hopper.

The coal bunkers, and particularly the coal hopper, are subjected to very rough treatment; coal is dropped from regular steel hopper coal cars directly into the Service Company's hopper, then elevated and dropped into the coal bunkers, the coal having first been prepared for the stoker. After several months' usage and tests an inspection of the concrete lining shows there has been no noticeable abrasion of the surface, and the whole work is regarded as entirely successful.

TREND OF HIGHWAY TRANSPORT EDUCATION IN THE UNITED STATES

By Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan, Ann Arbor, Mich.

What is included in highway transport education? I conceive that highway transport education should cover the fundamentals of the science, art, economics and business of the transportation of passengers and commodities over highways.

Courses in this field will be taken by men looking forward to the profession of highway transport engineering, the motor vehicle industry, and the businesses of traffic management and highway transport.

In the opinion of some, highway transport may not be considered as belonging to the field of technical training and education. On sober thought, however, it will be seen that this branch of knowledge comes well within the classic definition of engineering embodied in the Royal Charter of the Institution of Civil Engineers of Great Britain, which in part is as follows: "The art of directing the great sources of power in nature for the use and convenience of man as the means of production and of traffic in states both for external and internal trade."

From the standpoint of highway transport business, courses in this field will be taken by men who desire to equip themselves efficiently for the positions of business administrators, dealers, salesmen and advertisers in the motor vehicle industry, and executives, operators, traffic managers, motor truck fleet managers and dispatchers in the commercial field of highway transport, and in the closely related fields of railway and waterway transport.

Demand for Highway Transport Engineers

What is the demand for highway transport engineers and men equipped for highway transport business? In May, 1920, the First National Conference on Highway Engineering and Highway Transport Education held in Washington, D. C., unanimously adopted the conclusion that 4,000 men should be trained in highway transport each year in universities for the positions heretofore enumerated. Many have misinterpreted the meaning of this conclusion. Emphasis should be placed on the words, "*should be trained.*" The representative committee framing this conclusion had in mind the economic and efficient utilization of highway transport in the transportation system of the United States. They did not say that there was an immediate call for 4,000 trained men each year, but they did imply that the country would be benefited by having 4,000 men trained each year and their services utilized in the field of highway transport.

What is the present situation in regard to the demand for highway transport engineers and men trained in the business of highway transport? While it is true that the University of Michigan, which first instituted courses in highway transport and is in the heart of the motor vehicle industry, has no difficulty in placing its men in the highway transport field, the number of well paid positions available in this field at the present time is comparatively small. Why does this condition exist? The answer is simple. The potential users of men trained in highway transport are not educated to the value of the services of such men.

Allow me respectfully to suggest that the Highway Education Board devote at least as much time to the spread of propaganda among potential users of men trained in highway transport as in encouraging the universities throughout the United States to establish courses in highway transport. A herculean task must be consummated in this field if we are to see highway transport take its proper economic place in the transportation system of America.

Many highway departments are not properly designing the highways for even

immediate future traffic because their personnel does not include men who have had a proper training in highway transport to have a vision and adequate background which will enable them to diagnose the probable development of traffic on a given highway, or, in other words, to make the prerequisite of economic highway design a highway transport survey, which embodies all investigations in the field and office which are necessary efficiently to estimate the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts.

A new Division in State Highway Departments. The establishment of a sound highway transport business is based on results of an exhaustive transport survey. Why should not the same policy be followed when the economic investment of milions of dollars in highway improvements is at stake?

In order that highway transport surveys should be properly conducted and adequate provision be made for the economic design, construction and maintenance of highways, each State Highway Department should create a Highway Transport Division. The duties of this division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of highways and their efficient use by pedestrians and all classes of vehicles. One of the most important functions of such a division would be to make highway transport surveys as preliminary to the design and re-design of state highways, the determination of efficient methods of maintenance, and the formulation of recommendations pertaining to efficient traffic and transport regulations.

Men asigned to a Highway Transport Division should be experienced highway engineers who have or are rapidly acquiring a knowledge of the following subjects: Highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities, and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

In order to secure and retain the services of engineers qualified to occupy responsible positions in a Highway Transport Division, it will be necessary for State Highway Departments to pay salaries ranging from $3,600 to $10,000. Not only will the economic law of demand and supply in the highway engineering field necessitate the payment of proper salaries to engineers trained and experienced in highway transport, but highway departments will be forced to compete with the commercial demand for the services of such men.

Motor truck manufacturers' organizations are in a chaotic condition from the standpoint of the proper utilization of men trained in highway transport. Why? In general, they have followed in the obliterated footsteps of companies manufacturing highway machinery and materials. The latter companies originally established departments which were advertised to give unbiased consulting service to their customers. Motor truck companies established a few years ago highway transport engineering departments, and advertised to make a complete highway transport survey covering the requirements of a prospective user of motor trucks and to give unbiased advice pertaining to the purchase of equipment. What was the result? In the first place, it was found impracticable to divorce unbiased opinion from the commercial interests of the organization represented, and soon prospective customers began to realize this self-evident fact. Second, disastrous conflict arose between the highway transport engineering department and the sales organization, a natural result to anyone familiar with the interrelationship existing between the activites of such departments. What was the final outcome in the case of companies manufacturing highway materials and machinery? The natural logical conclusion was reached that the sales organization should contain men trained in the fundamentals of highway engineering practice and the efficient use of the machinery or materials manufactured by a given company, and that advice should be restricted to the efficient and economic utilization of the machinery or materials manufactured. The results have been beneficial not only from the standpoint of the commercial organizations concerned, but also from the standpoint of the general highway engineering profession and the public which ultimately benefited by increased efficiency. All are familiar with the efficient services rendered along these lines by such commercial organizations as The Asphalt Association, The Barrett Company, The Granite Block Manufacturers' Association,

The Jennison-Wright Company, The National Paving Brick Manufacturers' Association, The Portland Cement Association, The Texas Company and many others. I predict that in the near future the motor truck manufacturers of this country will see the light and follow in the footsteps of the closely related companies who have already passed through the transition stage. Concretely stated, the sales organizations of motor truck, tractor and trailer companies should be composed of men trained in the fundamentals of highway transport and the efficient use of the equipment manufactured by the company which they represent.

Failures of highway transport enterprises are occurring every day, due to a lack of knowledge of the fundamentals of the economics, science and art of highway transport. It is reported that 90 per cent of all highway transport companies doing business with New York City as a center fail within three years after entering this field. While 50 per cent may fail, due to cut-throat competition by fly-by-night companies, it is conservatively estimated that at least 50 per cent fail because of lack of knowledge of the A B C's of efficient highway transport business methods, cost accounting, management and the operation and maintenance of equipment. The Highway Education Board has a big task before it in bringing to the attention of groups of business men or capitalists, operators and prospective operators of highway transport, the necessity of having connected with their operating organizations men who are thoroughly trained in the methods of highway transport, the interrelationship of highway, railway and waterway transport, highway transport legislation, the fundamentals of highway transport cost and record systems and the principles of highway transport management, together, of course, with a knowledge of the mechanism, operation and maintenance of motor trucks, tractors and trailers.

We find a satisfactory status relative to the development of highway transport education in the universities throughout the United States. In some institutions the logical development occurs by the men having charge of highway engineering courses giving courses in the related field by highway transport. In other institutions, such courses are offered by the Department of Economics or Business Administration. If these departments are to teach highway transport efficiently, the instructors must have a knowledge of the fundamentals of the economics and science of highway engineering and practical highway transport. It is expected that notable developments will take place along these lines, especially when authoritative texts are available. We have a development in the main of undergraduate instruction in the fundamentals of highway transport. In this connection, allow me to emphasize strongly a recommendation which I have made at the University of Michigan that all engineers should be required to take, as a part of their curricula, a fundamental course in "*Transportation*," which would cover the economics of the utilization and operation of highway, railway and waterway transport.

Naturally, developments in the graduate field have been slow, due, first, to a lack of demand by students for such courses; second, because there are few instructors who feel capable of giving graduate instruction in this field; and, third, due to a lack of the necessary financial support by institutional administrators.

As soon as the demand from potential users develops it will be necessary materially to speed up the training of mature men as well as college students in the fundamentals of highway transport. It is my belief that the Graduate Short Period Course offers the most efficient method of training mature men who may be connected with motor truck or trailer manufacturers' promotion and sales organizations; traffic departments of plants, factories, wholesale and retail stores, steam and electric railroads and waterway transportation companies; highway transport enterprises, and state, county or municipal highway departments. Such courses in the field of highway engineering and highway transport are developing rapidly at the university which I have the honor to represent. Eighteen of these courses are given in periods of two weeks each during the months from December to March inclusive. Each course consists of 30 lectures, or the equivalent thereof, and counts as two hours credit towards the total of 24 hours required for the Master's degree. Persons of mature age, who do not hold collegiate or technical degrees, may register for these courses as special students, not candidates for a degree. In the first year, 1919-1920, when such courses were offered at the University of Michigan, the attendance was 29. In 1920-1921 the attendance increased to 45, while in 1921-1922, 94 men were registered in these

courses, the average age of the men being 27 years, ranging from 22 to 54 years. They came from all over the United States and some from foreign countries. They represented universities; state, county and municipal highway departments, consulting engineers' offices; contractors' organizations; companies manufacturing motor trucks, highway machinery and materials, and from the field of highway transport business. About 50 per cent of these men were graduate engineers, registered in the Graduate School for the Master's degree, 16 Master's degrees being awarded in June, 1922, to men with a major subject in highway engineering or highway transport. The other 50 per cent were mature men in practice who had not had a college training. It should be stated that all men are on an equal footing in these graduate courses, and take an equal part in the discussions of the many subjects considered.

In this connection I wish to reiterate my recommendation at the 1920 conference that at least ten universities, located in different geographical sections of the United States, offer Graduate Short Period Courses covering the various phases of highway transport, if they are financially able to engage the proper personnel and provide sufficient equipment for carrying on graduate work in this field. It is earnestly hoped that this recommendation may be favorably considered by administrative bodies of some leading universities, and that they will adopt the broad-visioned policies of Dr. Marion L. Burton, President of the University of Michigan, and the Board of Regents, who have provided adequate personnel and physical equipment for the efficient development of graduate instruction and research in highway engineering and highway transport as shown, first, by their action in establishing a chair of Highway Engineering and Highway Transport, and appointment of two assistant professors, a librarian of the Davis Library of Highway Engineering and Highway Transport, an instructor and three assistants in Highway Engineering, and, second, in their assigning two floors of one wing, 65 ft. by 225 ft., of the new $750,000 Engineering Building to the Division of Highway Engineering and Highway Transport.

The foregoing paper by Prof. Blanchard was presented at the second National Conference on Highway Engineering and Highway Transport Education held in Washington, D. C., on Oct. 26, 1922.

HINTS ON HAULAGE OF LEAN MIXTURES OF CONCRETE

By C. C. Wiley, Asst. Prof. Highway Engineering, University of Illinois, 201 Engineering Hall, Urbana, Ill.

The wet haulage of rich mixtures of concrete, such as are used for concrete roads, has met with unusual success. The haulage of the leaner mixtures, however, has not been as satisfactory, but even such mixtures can be hauled with fair results if some precautions are taken.

During the past summer in the city of Champaign, Ill., it was desired to lay a 6-in. concrete foundation for a brick pavement. The contractor had been laying concrete pavements from a central mixing plant and desired to use this method on this concrete base.

The specifications called for a 1:3:5 mixture. The aggregates were sand and gravel, both of which were fairly well graded, but the sand especially tended towards coarseness. The resulting concrete, therefore, was somewhat harsh and difficult to finish.

The concrete was hauled in Lee bodies mounted on Ford trucks. The distance was 2.6 mile, all on fair to good brick pavement. Every batch received was mixed at least one minute and many of them twice as much.

At the start of the work it was found very difficult to spread the concrete and secure a surface that could be finished; in fact, some 20 ft. of the concrete had to have added to it a thin grout coat to fill up the spaces between the coarse aggregates and make the surface smooth and solid.

It was found that a wet consistency would come on the job with 2 or 3 ins. of water on top of the load and the bottom of it very dense and solid, necessitating the use of a pick to get it out. On the other hand, dry mixtures would be more or less solid all the way down and were too harsh to move into place and finish. After a number of trials the following method was developed:

1. The consistency such that about 1 in. of water stood on top of the concrete when it reached the job.

2. The truck was backed close to the concrete in place so that the new load was discharged on top of that already delivered. This pile was then pulled forward into place.

3. In dumping the truck, care was taken that the body should, on the first attempt, swing to its full unloading posi-

tion in order to give some inertia to the contents, which almost invariably threw the entire load out of the body.

By following this scheme carefully it was found entirely possible to get reasonably good results. If a batch came a little too wet, the slush became reunited as the mass of concrete was pulled forward into place and so caused little difficulty. If a batch came too dry, the end of a hose was inserted in the pile and a very gentle stream of water admitted. This seemed to percolate through the pile and reduce its consistency without washing out the fine material.

The surface of the concrete was struck off with a strike-board and then finished by means of long-handled wood floats. The finished surface was nearly as smooth and free from porous places as a concrete pavement, although not quite as evenly finished. It was found that belting was of little service.

MAINTENANCE OF EARTH ROADS WITH CINDERS AND COLD ASPHALTIC OIL IN BOROUGH OF QUEENS, NEW YOR CITY

Considerable interesting experimental work has been carried on in recent years by the Borough of Queens, with types of pavements which depart materially from local prevailing practice.

One of the most satisfactory results have been in the maintenance of dirt roads with cinders and cold asphaltic oil, as described by Messrs. E. E. Butterfield and Fred H. Shepheard.

There are between 600 and 700 miles of dirt roads in the Borough of Queens, which in a rapidly developing community must be kept open to traffic and which should be in condition to receive more varied and heavier traffic. In the winter and spring many of these roads were formerly impassable. The treatment these roads now appear to approach the stability of a macadam pavement and fur- of these roads with cinders and cold asphaltic oil has changed all of this and thermore, to retain this stability for at least one year which is as far as our experience goes..

The method which was somewhat improved in 1921 is as follows: The dirt road is honed and shaped (Ford Tractor and Jumbo Road Machine), the cinders are then spread by laborers with coal scoops. The cinders are then slightly compacted by a short rolling with 10-ton roller. The asphaltic oil is then applied and the roadway is given a final and thorough rolling. The result is a firm, smooth surface. In 1920, we used 7,000 tons of cinders for this purpose with most satisfactory results and so few of the roads required treatment after the winter of 1920-1921 that in the season of 1921 we have used 23,000 tons of cinders, corresponding to about 25 miles of roads, up to November 1st. The cost in 1920 was $0.27 per sq. yd. and in 1921, $0.258, wages being the same for both years.

PATCHING ASPHALTIC PAVEMENTS IN ZERO WEATHER

A method of repairing asphalt pavements during the winter months, when municipal and county asphalt plants usually are closed down, has been evolved with success by Charles L. Harrison, engineer of street repairs at Cincinnati.

The old asphalt pavement is removed from the streets and hauled to the yards during the regular working season, the pavement being broken down to approximately 2½ ins. The heating plant consists of 4 horizontal, 4-wheeled tar kettles, each of 100 gal. capacity. The old asphalt, broken to proper size, is placed in the kettles in the afternoon and the fire started at 5 o'clock the next morning. Four or 5 gals. of water are added and the covers are placed on the kettles, after being allowed to steam for half an hour the mixture is turned over with heavy bars, is spaded at one end and then allowed to steam again. The operation is repeated until at the end of 3 hours the water has evaporated and the mixture is ready for use at a temperature of 325 to 375 degrees Farenheit. It is then transferred to another kettle, under which a hot fire has been built, and is hauled therein to the street where it is laid in the same manner as "new stuff," except that it is tamped into place instead of being rolled. The 4 kettles are never allowed to be more than half full, as the mixing cannot be done in an economical manner if the kettles are full.

The force engaged in breaking, heating and laying the asphalt in Cincinnati consists of only the 7 men who are kept during the winter as the nucleus for the spring force and a driver for a 2-horse wagon. No additional bitumen or dust filler is added to the old asphalt and the cost is slightly less than the average cost per square yard for repairs with new material.

Construction News and Equipment

REGULATION OF OVERLOADING OF MOTOR TRUCKS

By David C. Fenner, Manager Public Works Department, International Motor Co., 25 Broadway, New York, N. Y.

(Editor's note: That the motor vehicle industry favors proper regulation of truck loading is emphasized in the following paper presented by Mr. Fenner at the recent joint session of the North Central Division of the National Highway Traffic Association and the Michigan State Good Roads Association.)

Effective regulation can be accomplished only after careful investigation and determination of the direction and amount of deviation from standards of normal practice. When we attempt to determine the facts regarding the loading of motor trucks we are handicapped by the lack of a standard which can be used as a practical basis of comparison.

A motor truck is a carrying tool, but not necessarily a measuring tool. It should be placed in the same general classification with the shovel and the wheelbarrow, and not with the quart and peck measure and the bushel basket.

The overloading of motor trucks is due in part to the improper basis of rating and classifying the motor truck chassis in terms of the manufacturer's rated pay load capacity. The user soon learns that this rating really does not mean anything. He purchases a motor truck chassis, attaches a body which may or may not fit either the chassis or the commodity to be carried and he then loads this truck to suit himself.

Select Chassis to Fit Commodity and Body

It would seem, indeed, that the motor truck body is the real measure of capacity which determines the size of chassis, which must be used to carry it, loaded with the commodity to be hauled.

In the sale of motor transportation, the successful salesman conducts a careful survey, the results of which convince the customer that a certain type, size, capacity and weight of body is necessary to fill his transportation requirements. He sells his customer this particular type, size, capacity and weight of body, and then, and not until then, is he in a position to sell the customer the proper type and size of chassis to carry this body loaded to capacity with the particular commodity that it is purchased to haul.

The large number of misfit motor trucks on the road today are the best possible examples of the other method of selling the motor truck chassis first and allowing the customer to put on the chassis any old body and load it in any old way.

Each chassis when it leaves the manufacturer's plant has a definite rated capacity for both the body weight and the weight of the load. If a particularly heavy body is mounted, or if various forms of auxiliary power devices are mounted in addition to the body and the dead weight of the body and these power devices exceed the body weight allowance determined by the chassis manufacturer, the pay load capacity must be reduced by the amount of this excess. In the case of dump bodies with hoists and transmission power take off for driving them, power-driven winches, pumps, air compressors and various other forms of auxiliary power devices, this excess weight is a considerable amount, and in many cases overloading would be reduced if a larger capacity chassis were used.

Caution Plates

Manufacturers have suggested that state motor vehicle commissioners should refuse a state motor vehicle license for any truck which is not equipped with a stamped with the actual weight of the manufacturer's caution plate properly chassis, body and load capacity.

Manufacturers are now proposing to go a step further and indicate on this plate the maximum allowable gross load for the front axle, the maximum allowable gross load for the rear axle, the maximum allowable speed and the distance in which the vehicle loaded to capacity can be stopped with each set of brakes operated independently with the vehicle running at the above maximum speed on a hard, dry, level roadway. The information on this caution plate will give the owner the data he needs for painting the weight and carrying capacity on the sides of the vehicle to comply with the

local state law. It will also enable the local enforcement officer to check up the distribution of weight between the axles, the maximum speed, and the condition of the braking system. A similar plate for use on homemade trucks can be issued by the state motor vehicle department. The information contained on this plate will prevent the operation of improper trucks and force the proper operation of good trucks. It will put the penalty for poorly adjusted brakes and steering connections directly up to the operator, where it belongs.

Some states are considering the suspension of a driver's license for three months as a penalty for faulty brakes.

Excuses for Overloading

Let us consider briefly the cause of reasoning which the owner follows as an excuse for overloading:

1. Beating the law.
2. Beating the state out of the proper amount of license fees.
3. Beating the rates of a competitor.
4. Beating the purchase price of the truck.
5. Wilful, persistent overloading in the face of all the facts.

Let us also briefly consider the result of these practices:

1. The man who overloads to beat the law ultimately runs afoul the local enforecement officer. The lightest penalty, if any, forces him to leave his excess load alongside the highway and the heaviest penalty forces him to leave his truck and its load with the state authorities until such time as his case comes before the court and is decided. In some cases this may require from six to eight weeks. In either of the above cases both the owner and the operator are subject to fine and suspension of license.

2. The man who overloads to beat the state out of the proper license fee will ultimately have to forfeit his low rating license and the money which he paid for it, and be forced to take out a new license based on the gross weight which the truck was carrying at the time of his arrest and at the higher fee. Under the new license, however, he will not be allowed to carry more than the manufacturer's rate of capacity for the vehicle and its tire equipment.

3. The man who overloads to beat the rate of a competitor finds the practice unprofitable and ruinous in the long run. He does not benefit himself in any way. Rather he is benefitting his customer ot whom he makes a present of the depreciation on his equipment.

4. The man who overloads to beat the purchase price of his truck or say, rather, to take advantage of the "overload capacity" offered by some truck salesmen is up against the general law of averages. In the end he gets just about what he pays for and no more. You can be sure that the owner who follows this practice keeps no operating costs that are worthy of the name.

5. The man who persists in wilful overloading in the face of all the facts is a menace to public safety, and should permanently be refused either a vehicle or an operator's license. He has forfeited his right to the use of the highway and a few less of his kind on the highway will be a distance benefit to highway transportation.

Allow me to quote from a statement recently issued by Mr. Joseph F. Whelon, one of the most successful and progressive professional truck operators in New York City:

"With regard to the perpetual statement that the regulation of loads to the manufacturer's rated capacity would put the truckman out of business, I would say that this is not so. Such regulation instead of putting truckmen out of business would help them materially. If it did nothing else, it would bring to a halt the activities of the irresponsible operators who have no regard either for their mortgaged equipment or for their legitimate competitors.

"If truck loads were regulated it would mean that prices could be standardized, and that much equipment that is now idle might be operated at a fair profit because additonal trucks would be needed to carry the freight formerly piled haphazardly upon two or three long suffering and much abused vehicles."

Investigations conducted in some of our states show that the light and medium capacity vehicles are overloaded to a greater extent and in greater numbers than the heavy capacity vehicle. This indicates the importance of restricting loads per inch width of tire per wheel and per axle. We must recognize the four clases of tire, pneumatic, cushion, solid rubber and metal for regulating speed and the determination of license fees according to wheel load. We must

restrict the minimum thickness of solid and cushion tires when measured between the tire flange and a flat metal surface on which the wheel stands. We must also take into account the condition of tire.

The safety of the public, the preservation of the highway, the economy of vehicle operation, the status of the operator and the successful and economic development of highway transportation all demand that the practice of overloading should be discouraged, forbidden, prohibited and stamped out completely.

Let every week be a safety week in which we conduct a campaign against overloading. If you are a truck owner and operator, give your trucking department very definite insructions regarding proper loading of highway vehicles. If you purchase your trucking on a rental basis, refuse to patronize those professional truckmen who persist in overloading.

Put it up to your local motor truck association to stop this practice of overloading or take the consequences of a concerted action of the local automobile owners' association and the local chamber of commerce to report to the enforcement officers every truck which shows the slightest evidence of being loaded beyond its capacity.

Let us take all the pleasure and the satisfaction out of overloading. Then the chap who has been overloading just to beat the game will quit, and the chap who is really forced by circumstances to haul more than the rated capacity of his present vehicle will either buy a larger vehicle or a semi-trailer and omunt the front end of this trailer on a fifth wheel attached to the frame of his present vehicle over its rear axle. By this means he can double the capacity of his present vehicle, and by distributing his gross load over six wheels, four of which are rolling and only two driven, he can keep within the wheel weight restrictions of the state law and the manufacturer's rated capacity of the truck, help to preserve the safety of the public and the best interests of highway transportation.

The motor vehicle industry stands solidly behind the rigid enforcement of the provisions of the Proposed Uniform Vehicle Law and the existing state laws. It condemns overloading and overspeedtng unreservedly, and will co-operate actively in every movement to regulate loads and speeds of motor trucks on the highway.

NEW LINE OF SMALL VERTICAL BELT DRIVEN AIR COMPRESSORS

The Ingersoll-Rand Company, 11 Broadway, New York, announces a new line of small vertical belt-driven air compressors known as Type Fifteen. In addition to the plain belt drive design each size is built as a self-contained electric motor outfit, driven through pinion and internal gears, or by employing the short belt drive arrangement. The compressing end and electric motor of both gear and short belt drive units are furnished mounted on a common sub-base, so that they are in no way dependent upon the foundation for correct alignment.

Several noteworthy features of construction have been incorporated, of which the "constant-level" lubrication system is the most important. Others include the constant speed unloader for plain belt drive machines; the centrifugal unloader for start and stop control machines, and the increased size of the water reservoir cooling pot.

The lubrication of small vertical compressors employing the enclosed crank case and splash system has often been a source of concern wherever oil in the air is a serious menace. The tendency of the old system has been to feed too much resulting in discharged air containing excess oil, or too little causing scored cylinders, excess loads and burned out bearings.

The "constant-level" system used in type fifteen compressors automatically maintains a constant-level of oil, which insures the right amount being distributed to all parts.

As with the ordinary splash system, the base of the compressor forms an oil reservoir for the "constant-level" system. However, with this system, pet cocks determine the maximum and minimum amount of oil in the reservoir. Above this reservoir and directly underneath the connecting rod is a constant-level pan. Oil is pumped from the reservoir into this constant-level pan through a unique oil pump. Regardless of the amount of oil in the reservoir, so long as it is somewhere between the high and low level pet cocks, this system will function perfectly, insuring a constant-level of oil in the pan. A projecting stem on the connecting rod dips into this pan and distributes just a sufficient quantity of oil for proper lubrication.

The constant speed unloader controls

the unloading of the compressor by automatically opening the inlet valve when the receiver pressure rises above that at which the unloader is set to operate. When the receiver pressure has fallen a predetermined amount, the unloader automatically releases the inlet valve and allows the compressor to return to work and thus build up the receiver pressure again.

The centrifugal unloader allows the compressor to start under "no load" such as is essential when automatic start and stop control is used, and permits the electric driving motor to come up to full speed before the load is thrown on automatically. This unloader accomplishes its purpose by holding the inlet valve open until the motor has reached full speed.

The smallest size is built with either ribbed cylinder for air cooling, where the service is intermittent, or a water jacketed cylinder of the reservoir type for constant service. All other sizes are only built with the water jacket of the reservoir type. The size of these reservoir pots is very generous, and one filling will be found sufficient for long periods of operation.

A NEW TYPE OF MULTI-STAGE CENTRIFUGAL PUMP

Many engineers are not aware of the high efficiencies that can be obtained in centrifugal pumps by the use of a properly designed and proportioned volute rather than by the use of diffusion vanes.

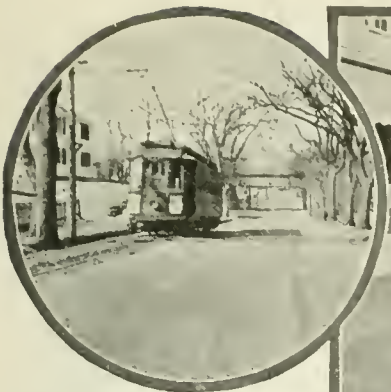
That the highest efficiencies are obtained with volute diffusors is best demonstrated by numerous official tests on volute type centrifugal pumps in water works service. For example, one installed at the municipal water works in Minneapolis has maintained the uniformly high efficiency of 86 per cent over a period of 4 years, during which time no replacements or repairs whatever have been made to the pump, while another at Toronto showed an efficiency of 87.2 per cent in a recent official acceptance test.

The Minneapolis and Toronto pumps are single-stage machines, but the enclosed article describes a multi-stage pump in which the advantages of the volute construction are retained, together with those of double suction impellers, including self-balancing and adaptability to high speeds.

Where pumps driven by motors of slow or moderate speeds must deliver water at pressures higher than are desirable or practicable for a single-stage pump, instead of using a single-suction multi-stage pump, two separate single-stage pumps are sometimes connected in series, so that one discharges into the suction of the other. This method has frequently been adopted, particularly in water works service. In medium and smaller sizes the use of two independent pumps in series becomes somewhat more cumbersome, and a multi-stage pump is more often used. The length of shaft permissible in a multi-stage pump is limited because of the critical speed, and if many stages are employed the designer no longer has a free hand in providing water passages of the shape and size conducive to the highest efficiency. Consequently, where more than three stages are required, the single suction impeller which occupies less space on the shaft than does the double suction impeller, and thus permits the use of a shorter shaft, is used.

However, it is not possible to obtain as high efficiencies with a commercial multi-stage single suction pump as would be possible in a single-stage pump with double suction impellers, not only because of the less favorable limitations imposed on the impeller, but also because there is not sufficient space for an efficient volute diffusor and suitable return passages leading from the diffusor to the eye of the succeeding impeller. The De Laval Steam Turbine Co. therefore developed a new type of multi-stage pump, known as a "series" pump, in which the advantages of the double suction impeller are retained. This is made possible by the use of a specially formed casing, which provides individual volutes for each impeller, with ample interconnecting passages within the casing itself.

The double suction impeller gives perfect hydraulic balance, and two of the stuffing boxes, which would be required if two separate casings were employed, are eliminated, together with their friction. As compared with a single suction impeller, the double suction impeller has a smaller suction eye, which permits of making the impeller itself smaller in diameter, and hence the pump can be built to operate at a higher speed for a given head and capacity, or for the same speed, head and capacity, a higher efficiency is obtained. Besides giving the highest efficiency, the volute type diffusor is superior to diffusion vanes, in that it is not subject to clogging or rapid wear, and it also gives a broader efficiency



Court Street: The original "Tarvia-X" street built in 1909 and still a credit to the town.

Civic Center: An Example of "Tarvia-X" construction and maintenance, originally built in 1910.

Tarvia in Plymouth, Mass.

THIRTEEN years is a short period in the history of Old Plymouth. But it is a long time for inexpensive pavement to withstand modern traffic, with next to no maintenance.

Mr. Arthur E. Blackmer, Superintendent of Public Works, writes:

"Our experience with Tarvia covers a period of consistent use for thirteen years—the town now has thirteen miles of Tarvia macadam.

"At the recent tercentenary celebration, held in the summer of 1921, over a million strangers visited this historic town, and Tarvia again proved its worth by satisfactorily protecting the roads, even though subjected to the consequent unusual traffic."

North Street: Familiar to all the pilgrims to Plymouth Rock as a Tarvia street for the last 13 years. In addition to pleasure traffic it has taken the teaming from Plymouth wharves.

Plymouth has found through long experience that Tarvia construction insures maximum mileage of well-paved streets—that its moderate first cost permits a more extensive paving program, and its economical maintenance materially reduces the annual upkeep expense.

Not only in Plymouth, but in countless other cities and towns throughout the country, Tarvia is saving money for the taxpayers and providing better streets for all kinds of traffic.

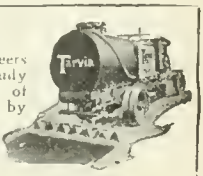
Illustrated booklets of the various Tarvia treatments free upon request.

Tarvia

For Road Construction Repair and Maintenance

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.



New York, Chicago, Philadelphia, Boston, Detroit, New Orleans, Birmingham, Kansas City, Peoria, Atlanta, Duluth, Milwaukee, Youngstown, Toledo, Columbus, Richmond, Baltimore, Omaha, Jacksonville, Houston

The Barrett Company

St. Louis, Minneapolis, Bangor, Latrobe, Denver, Cleveland, Dallas, Washington, Bethlehem, Cincinnati, Syracuse, Johnstown, Elizabeth, Pittsburgh, Salt Lake City, Lebanon, Buffalo

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B, Halifax, N. S.

curve, that is, a higher average efficiency over a wide range of delivery.

The pump casing is made in two parts, divided on a horizontal plane passing through the center line of the shaft, the suction and discharge openings being in the lower part, so that they are not disturbed when the casing cover is lifted. Perfect form and smoothness in the suction and discharge chambers and the passages connecting the volute of one stage to the suction chamber of the succeeding stage is secured by the use of dry sand molds in casting the casing and cover.

Leakage from the discharge chamber of each impeller back to the suction chamber of the same impeller is prevented by the use of labyrinth wearing rings. One ring of each pair, known as the case protecting ring, is held in a recess formed in the casing and the casing cover. The other ring, known as the impeller protecting ring, is screwed onto the impeller. The intermeshing grooves of the labyrinth rings present a long and tortuous path to water leaking from the discharge to the suction chamber, thus greatly reducing leakage, while at the same time permitting the use of amply large running clearances. One proof of the effectivenes of this device in preveting leakage is the much longer life of such rings as compared with ordinary flat wearing rings.

To prevent leakage from the suction chamber of one impeller to the suction chamber of the succeeding impeller, that is, from stage to stage, the bushings, where the shaft passes through the partitions between stages, are made of ample length. The shaft is protected between the impellers and from the impellers to the outer ends of the stuffing boxes by bronze sleeves, and the pump case and cover by bushings at the partitions. Sufficient clearance is provided so that the shaft sleeve and the pump casing bushing are not in metallic contact.

The efficiency curve of the series design is remarkably flat, that is, a high efficiency is maintained over a wide range of delivery. This is obviously a great advantage, and distinguishes this type of pump from pumps in which diffusion vanes instead of volutes are used for converting the velocity of the water leaving the impeller into pressure head. In other words, the advantage in this respect of the single-stage volute pump is now extended to multi-stage pumps of two and three stages.

DETERMINATION OF BRIDGE FOUNDATIONS BY WASH BORING

In the examination of bridge sites throughout North Carolina the Bridge Department of the State Highway Commission has used the wash boring outfit with success and the following description of it by P. K. Schuyler appeared in the North Carolina Highway Bulletin recently.

The apparatus was designed by H. C. Scott, construction engineer, and was built at the "Truck Patch" of the Commission. It consists of a 2-in. casing pipe which is driven into the ground by a 120 lb. hammer pulled up by hand in a set of 16 ft. leads and allowed to drop. Inside of this casing pipe is a wash pipe ¾-in. in diameter through which water is forced under 30 lbs. pressure by a 2 H. P. gasoline engine. The material is washed up between this pipe and the casing and is caught in a bucket or some vessel for examination. The outfit is transported from place to place in a "G.M.C." Light Aviation truck, rigged up especially for this purpose. Practically all of the material used in the construction of the outfit was obtained from surplus war material allotted to the State from the Federal Government thus making the construction cost practically nothing. The truck in which it is transported was also allotted to the State from surplus war supplies. The total cost of operation, including all overhead expenses, runs about 75c per lineal foot of boring up to 50 ft. which is the greatest depth that the machine is capable of boring. The force required to run the outfit consists of an engineer in charge, a truck driver, who also operates the pumping engine, and two laborers who are obtained locally. One boring requires about one day, much of the time being consumed in unloading and making the set up.

The saving to the State by the use of this outfit has been considerable since the results obtained often bring about a change in the contemplated design and further enables the contractor bidding on the work to know just what conditions he will encounter thereby making it possible for him to submit a lower initial bid.

Contracts Awarded

ROADS AND STREETS

Ala., Montgomery—State Hwy. Dept. 1st contr. for grading and surfacing with gravel and 2½-in. penetration macadam 7.648 mi. Huntsville-Guntersville Rd. Madison Co., to Williams Bros. Constr. Co. and M. W. London & Son Roanoke, Va., at $124,057; grading & surfacing with 1½-in. penetrating macadam 6.87 mi. Decatur-Moulton Rd., Lawrence Co., to Stanley & Singer Constr. Co., Lafayette, at $181,917.

Ariz., Phoenix—Following contracts let by State Hwy. Dept.: Lee-Moor Contracting Co., El Paso, Tex., contract for 6.1536 mi. ,impvt. of Geronimo-Solomonvile Hwy., Fed. Proj. 43, at grand total of $171,602 (State furnishing materials); S. B. Shumway, Mesa, Ariz., contract for Sec. A, Prescott-Ash Fork Hwy., at $19,858.

Cal., Fullerton—Los Angeles Paving Co., 2900 Santa Fe Ave., Los Angeles, awarded contract for surfacing various streets with 3-in. Warrenite-bitulithic, at $10,000.

Cal., Long Beach—S. M. Kerns, 1034 Vina St., awarded contract to 33c sq. ft. for paving Cherry Ave. with 6-in. conc., about 173,781 sq. ft.

Cal., Sacramento—P. L. Burr, 823 Sheldon Bldg., San Francisco, awarded contract for grading and 5-in. gravel surfacing 13.5 mi. hwy. betw. Sneath Rd. and Half Moon Bay Rd., Div. 4, Route 55, Sects. A and B. San Mateo Co., at $336,814.

Colo., Denver—State Hwy. Dept. let contracts as fololws: Grading 1.453 mi. no. of Dillon toward Kremmling, F. A. P. 190, Summitt Co. 100 ft. steel truss brdg. over Blue River to Colo. Bridge & Constr. Co., Gas and Elec. Bldg., Denver, at $36,504; conc. paving 1.519 mi. Boulder Co., F. A. P. 222B, to Miller, Douglas & Hainer, 100 S. York St., Denver, at $56,885; gravel surfacing, 5.375 mi., Santa Fe Trail, Grenada St., line, F. A. P. 219A, 18 ft., Powers Co., to W. A. Colt & Son, Las Animas, at $52,607; 83 ft. conc. gird. brdg. over St. Charles River on Rye Rd. to Walsenburg with gravel approaches, F. A. P. 173, Pueblo, to J. R. Donaghew, Colorado Springs, at $24,650; grading 10.731 mi. rd. no. of Plattesville, F. A. P. 226-C, Weld Co. 16 ft. to C. R. Conover & Bro., 305 Bank Bldg., Denver, at $32,997; 7.474 mi. rd. F. A. P. 119B, to Girardet & Hotchkiss, Delta, at $44,654.

Kans., Iola—Fry Bros. Contg. Co., Iola, awarded contract for one course conc. 7.05 mi., F. A. P. 127, Sects. A and B, 75,000 sq. yds. conc., at $195,813.

Ky., Frankfort—State Hwy. Dept. let contracts as follows: Paving 12.775 mi. Barbourville-Pineville Rd. 14 ft. F. A. P. 39, Sec. A, rock asph. on conc., Knox & Kell Cos. to Metzel-O'Hearn & Lewen, Covington, at $338,398; 5.075 mi. Dixie Hwy., rein. conc. using vit. pipe, Boone Co., to Billiter & Oliver Bros., Covington, at $158,462; 13.92 mi. Camp Knox-Elizabethtown Rd. 16 ft. F. A. P. 79, bitum. macad. penetration, conc. pipe, Hardin Co., to R. B. Tyler, 114 S. 4th Street, Louisville, at $295,929; grading 9.717 mi. rd. from Morehead to Grayson, 24 to 28 ft. F. A. P. 68, cement rubble masonry, Carter Co., Hatfie'd Constr. Co., Huntington, W. Va., at $111,526; 8.103 mi. Stanton-Campton Rd., 24-28 ft. F. A. P. 71, using conc. pipe, Powell Co., to Codell-Byars, Winchester, at $153,787; 10,207 mi. Stanton-Campton Rd. 24-28 ft. F. A. P. 72, cement trubble headwalls and conc. pipe, Wolfe Co., to Vermillion Contg. Co., Barboursville, at $81,686; 2,087 mi. Hazard-Whitesburg Rd. 24-28 ft. F. A. P. 81, using conc. pipe, in Perry Co., to Codell-Byars, Winchester, at $87,061; 5.422 mi. Greensburg-Hodgenville Rd. 24-28 ft. St. Proj. 41, rein. conc. pipe, Green Co., to Ping Bros., Somerset, at $49,683; gravel surfacing, 2.891 mi. Cadiz-Hopkinsville Rd. 18 ft. F. A. P. 73, using bank gravel, Trigg Co., to Alexander Bros., Cadiz, at $36,063.

Fla., Dade City—Finley-Method Co., Graham Bldg., Jacksonville, awarded contract for grading and paving with asph. on 8-in. rock road 2, at $214,211; Rd. 3, at $90,402; grading and paving on sand-clay base rds 4 & 5, at $25,538; Rds. 6 & 7, $33,720; Rd. 8, $34,310; Rds. 9, 10 and 11, $74,488.

Ga., Atlanta—Following contracts let by State Hwy. Dept.: 8.738 mi. rd. on Atlanta-Newman Hwy., from Fairburn to Campbell-Coweta Co. line; 92,470 sq. yds. 6-in. by 18 ft. rein. conc. pavement, F. A. P. 174, Sees. C & D, to Davis Constr. Co., Macon, Ga., at $230,000; 9 mi. rd. on N. C. line to Blairsville Hwy. from Blue Ridge to Blairsville; grade and gravel surf. to H. H. Gardiner, Columbus, Ga., at $100,000.

Ia., Holstein—Western Asph. Paving Co., Sioux City, awarded contr. for paving and curbing various streets, 106,400 sq. yds. conc., 48,296 ft. curb and gutter, 7,082 ft. 7-in. curb, at $299,335.

Minn., Grand Marais—Campbell-Ames Co., 402 Manhattan Bldg., Duluth, awarded contract for grading and bridging 14 mi. State Proj. 1.05, F. A. P. 298, 24 ft., at $162,000.

Miss., Pascagoula—S. A. Gano, New Orleans, awarded contract for construction of 8.44 miles 18 ft. conc. hwy. from Pascagoula to Ala. State line, at $269,588.

Miss., Yazoo City—Lobby & Williams Engrg. Service, Inc., Yazoo City, awarded contract for paving 3.92 miles road, 1:2:3 mix. conc., 16 ft. including 172 ft. and two 99 ft. rein. conc. bridges, at $140,742.

Mo., St. Charles—State Hwy. Dept. let contract to Moreno-Burkham Co., St. Louis, at $670,000 for 3.166 mi. rd., Warrensburg to St. Charles; 2.637 mi. St. rd., Warrenton to St. Charles; 4.920 mi. same rd., 3.74 mi. and 3.783 mi. all Warrenton to St. Charles, Sections 66, 67, 70, 72 and 73.

Mo., Jefferson City—Contracts for constr. of 18 miles St. Louis to Kans. City Hwy., St. Charles Co., approved by St. Hwy. Comn., at $670,000. Moreno-Burkham Constr. Co., St. Louis, has contract and will begin work on project immediately.

Mo., Jefferson City—State Hwy. Dept. let following contracts: Clay Co., 10.60 mi. State Rd., Kans. City to Liberty, one course conc. pavement, F. A. P. 990, to American Paving Co., Omaha, Neb., at $315,195; Daviess Co. 12.320 mi. state rd. St. Aid Proj. 20,206, to Capitol Constr. Co., Des Moines, Ia., at $38,538, for grading and constructing draing. structs.

Mo., St. Louis—Webb-Kunze Constr. Co., 5927 Fyler Ave., awarded contract by Board Pub. Service, for impvt. of 5.080 ft. Watson Rd., 18 ft. rein. conc., at $137,744; McKelvey Constr. Co., 911 Title Guaranty Bldg., awarded contract for 25,000 ft. Penn., Wise and other streets, Westmoor subdiv. in Richmond Heights, 15,000 lin. ft. conc. curb and gutter, 75,000 sq. ft. 4-in. walk, 40,000 sq. yds. asph. mac, 1,000 ft. 63-in. segmental and 24,000 ft. 8-24-in. vit. clay sewer pipe, at about $200,000; also contract for impvt. of 3,600 ft. Parkwood Subdiv. Morganford and Loughborough Aves., 26 ft., 30,000 sq. ft. 4-in. walk, 31,000 c. y. earth excav., 80,000 sq. ft. waterbound macadam, 1,200 ft. 8-36-in. vit. sewer pipe, at about $33,730.

Mont., Great Falls—Following contracts let for road work in Cascade County: 1—F. A. P. 73, Belt-Riceville, 10.64 mi., grade to White, Brown & Leahy, Gt. Falls, at $93,753; brdgs. to McGuire & Blakeslee, Gt. Falls, at $24,936. 2—F. A. P. 72, removg. brdg. across Belt Crk. Belt Twp. and constructing new brdg. to McGuire & Blakeslee, at $22,435.

Mont., Helena—White, Brown & Leahy, Ford Bldg., Great Falls, awarded contract for grading, gravel surfacing, also bldg. structs. on 10.64 miles Belt-Riceville Rd., F. A. P. 73, Cascade Co., at $109,729.

Mont., Misoula—Siems-Carlson, Spokane, awarded contract for Belton-Nyack section of Belton-Java Rd., 6.82 miles, at $180,000.

N. J., Perth Amboy—Graham & McKeon, 319 Oak St., awarded contract for exten. to Route 4, Sec. 19, Amboy Ave., at $118,217.

N. Y., Brooklyn—Following contracts let for grading, flagging and curbing: E. 37th St. to F. Persicano, 350 Fulton St., N. York, at $1,550; T. B. Scott, 671 Halsey St., 82nd Street, at $1,650; repaving Nassau Ave. Navy & Wallabout Sts., to C. Gallagher, 745 Dean St., at $40,053; $8,071 and $34,164, respectively; 23rd St., to J. O'Hara, 557 3rd St., at $21,022.

N. C., Lexington—Harlee-Thrash Constr. Co., Florence, S. C., award. contract for 100,000 yds. asph. road betw. Lexington and Salisbury, at $150,000.

N. C., Raleigh—Lampton & Burks, Louisville, Ky., awarded contract by State Hwy. Comn., for 7.88 miles grading bet. Pollston and Wadesboro, Anson Co., at abt. $249,000.

N. C., Raleigh—Union Paving Co., Chicago, Ill., awarded contract for 220-282, Wayne-Duplin Cos., 28.75 mi. hard surf, rd. from Goldsboro to Warsaw, Route 40, at $708,011.90.

Ore., Salem—J. Hampshire, Ashland, awarded contract by St. Hwy. Department for grading 12.12 mi. Hayden Crk.-Kenosec. Ashland-Klamath Falls Hwy., Klamath Co.; surfacing Keene Crk.-Hayden Crk. sec. Ashland-Klamath Falls Hwy., Unit 1, 12.32 mi. Jackson Co., 24,000 cu. yds. broken stone, etc., to S. S. Shell Ashland, at $72,210; unit 2, 9.83 mi. Klamath Co., 19,000 cu. yds. broken stone, etc., to W. C. Stone, 654 E. Adler St., Portland, at $65,110; grading 9.35 mi. & surfacing 15.65 mi. Madras-Wasco Co. line, sec., the Dallas-Calif. Hwy., Jefferson Co., to Moore & Anderson, Heppner, at $81,843; 6 mi. grading Alsea Mtn. sect., Alsea Hwy., Benton Co., 43,000 sq. yds. com., 93,000 c. y. intermediate and 110,000 c. y. solid rock excav., at Joplin & Ekdin, Portland.

Okla., Madill—M. R. Amerman, 248 N. Market St., Wichita, Kans., awarded contract for paving, curbing and guttering 110 blocks, 110,000 sq. yds. rock asph., at $224,829.

Pa., Philadelphia—Barber Asphalt Paving Co., Land Title Bldg., award. contract for asph. and granite block pavement on Lancaster Ave., at $33,-668; asph. paving on Clearfield & Diamond Sts., Anderson, Etting and Sansom Sts., to Eastern Paving Co., Colonial Tr. Bldg., at $24,524 and $28,045, respect.; gradlng Algar St., to J. McCool, 124 Albanus St., at $31,161.

S. C., Greenville—J. T. Blassingame, Greenville, awarded contract for 15¼ miles State rd., Route 21, Cleveland to N. C. line, via Caesar's Head; 6¾ mi. claybound macadam; 9 mi. topsoil, at $178,000.

Tenn., Athens—P. M. Calloway & Co., awarded contract for street paving at $100,000.

Tenn., Johnson City—Municipal Paving & Constr. Co., Bristol, Tenn., awarded contract for 37,000 sq. yds. paving and 33,000 lin. ft. curb and gutter, covering 11 paving districts, at $100,000.

Tenn., Nashville—State Hwy. Dept. let contracts for following: 10.75 mi. road betw. Wilson Co. line and Carthage, Smith Co., F. A. P. 68, to Phillips, Simpson & McGugin Contg. Co., Stahlman Bldg., Nashville, at $161,849, for roadway, and $61,929 for bridges; 8.01 miles road betw. Tiptonville road and 6 miles west of Hornbeak, Lake and Obion Cos., F. A. P. 71, to J. Gray Constr. Co., Martin, Tenn., at $80,971.

Tenn., Newport—J. L. Humbard Co., Knoxville, Tenn., awarded contr. for 9.80 miles 8-in. limestone base road from Newport to N. C. state line, at $228,057.

Tex., Ballinger—J. B. Toomey, Ft. Worth, awarded contract for 10 blks. vit. brk. pavement, at $110,097.

Tex., Houston—Smith Bros., Sumpter Bldg., Dallas, awarded contr. for paving La Branch St., Texas to Holman Aves., at $126,943.

Tex., Lufkin—J. S. Moore & Sons, Lufkin, awarded contr. for grading, gravel surfacing, bitum. topping and bridging 9.72 miles St. Hwy. 7, Sec. A, F. A. P. 277, 16ft., at $170,317.

Tex., Pearsall—Uvalde Rock Asphalt Co., Cline, Tex., awarded contract for 17.8 miles State Hwy. 2; 49,460 cu. yds. gravel base, at about $300,000.

Utah, Salt Lake City—O. Nelson, Arimo Bldg., Logan, awarded contr. by State Rd. Comn., for grading and gravel surfacing 6.962 miles Sardine Canyon, 18 ft. F. A. P. 33, Boxelder Co., at $104,-194; Moran Paving Co., Felt Bldg., Salt Lake City, contract for grading and hard surfacing 6.413 mlles rd. from canal no. of Magna to Tooele Co. line, 18 ft. F. A. P. 39, Salt Lake Co., at $187,086.

Va., Richmond—Pardoe & Gillespie Co., Fairfax, awarded contract by State Hwy. Dept., Richmond, for constr. of 5½ miles Proj. 168, Route 6, 16 ft. bitum. macadam, at $134,877.

W. Va., Charleston—Smith & Quynn, Parkersburg, awarded contract by St. Hwy. Dept. for gravel surfacing 1.9 mi. Grape Island Raven Rock Rd. Proj. 58, Pleasants Co., 16 ft., at $21,900; grading and paving with rock asph., 2.7 Welch-Coalwood Rd. Proj. 3.153, McDowell Co., 16 ft. to Rogers & Shumway, Worthington, at $134,965.

W. Va., Charleston—State Road Comn. let contracts for grading and draining following: Berkeley Co., 4.24 mi. Martinsburg-Hedgesville Rd., waterbound mac., to Bester-Long Co., Hagerstown, Md., at $89,974; Boone Co. 4 mi. Ramage-Madison Rd., to Herling Constr Co., Akron, O., at $50,124; Boone Co. 1.7 mi. Racine-Peytona Rd., to Nash, Cain & Turmin, Huntington, W. Va., at $30,808; Calhoun Co. 11 mi. Grantsville-Arnoldsburg rd., to Hardman & McKown, Spencer, W. Va., at $169,586; Clay Co. 4.6 mi. Mayser-King rd., to W. C. Markle, Clay, W. Va., at $64,581; Gilmer Co. 10 mi. Glenville-Normantown rd., to Kelley Cons. Co., Clarksburg, W. Va., at $225,568; Grant Co. 2.4 mi. Petersburg-Hardy Co. line, waterbound macadam, to J. L. Chandler, Virgilina, Va., at $57,212; Hampshire Co., 8.6 mi. Juncton to Hardy Co. line, to J. L. Chandler, Virgilina, Va., at $100,632; Mason Co. 5.5 mi. Henderson-Couch rd., gravel surfacing, to Coleman Bros., Ashton, W. Va., at $84,964; Mason Co., 9 miles Point Pleasant-Clifton rd., gravel surfacing, to Jas. E. Doyle, Huntington, W. Va., at $93,840; Mercer Co. 6 miles Simmons-Freeman Rd., waterbound mac., to Jno. E. Dougher & Sons, Union, W. Va., at $19,081; Mineral Co., 7.6 mi. Ridgeley-Alaska, gravel surfacing, to J. L. Chandler, Virgilina, Va., at $65,110; Nicholas Co., 5.7 mi. Summerville-Gilboa rd. to Lookout Constr. Co., Victor, W. Va., at $61,265; Pocahontas Co., 4.23 mi. Buckeye-Millpoint Rd., to Frank Echols, Marlinton, W. Va., at $38,983; Raleigh Co., 4.2 mi. Shady Springs Flat Top rd., bitum. macadam, to John E. Dougher & Sons, Union, W. Va., at $147,-842; Raleigh & Wyoming Cos., 4.17 mi. Iroquois-Amigo Rds., to F. H. Franklin & Co., Pocahontas, Va., $83,548; Summers Co., 4. mi. from end of rd. to Raleigh Co. line to P. M. Price, Hinton, W. Va., at $52,080; Upshur Co. 6 mi. Buckhannon-Randolph Rd., to W. H. Rhodes, Elkins, W. Va., at $63,811; Webster Co., 11 miles Point Mountain-Randolph Co. line rd., to Mace Constr. Co., Webster Sprgs., W. Va., at $90,645; Wayne Co. 3.63 mi. Echo-Fleming rd., to Hartfield Constr. Co., Huntington, W. Va., at $151,800; Wirt Co. 12 mi. Elizabeth-Spencer rd., to Ebersbach Constr. Co., Pomeroy, O., at $234,788.

SEWERAGE AND SEWAGE TREATMENT

B. C., Point Grey—Harrison & Lamond, 601 Pacific Bldg., Vancouver, awarded general contract for constr. of sewer at $23,201.

Ont., Hamilton—Central Foundation Co., Ltd., 14 Wellington St., awarded contract (general) for constr. of storm and san. sewer, at $84,994, on Kenilworth Ave.

Que., Hull—Laflamme & Laflamme, 40 Langevin St., awarded contr. for bldg. sewers in various streets, at $42,695.

Cal., Los Angeles—M. Simunovich W. 2705 66th St., Hyde Park, award. con. for constr. of storm drain in 17th Dr., West Blvd. to Rimpau Blvd., at $6,959; Peter S. Tomich, 425 N. Fremont Ave., contr. for constructing sewer in Wedgewood Pl. and in parts of other streets, at $17,500; M. Simonuovich, 2705 W. 66th St., Hyde Park, awarded contract for constr. of sewer in Commonwealth Ave., at $977.

Cal., Madera—L. R. Adell, Madera, awarded contract for constr. of sewage disposal plant, at $32,-292.

Cal., Santa Ana—Joe Chutuk, 343 Wilcox Bldg., Los Angeles, awarded contract for constr. of 22,100 ft. segmental blk. sewer 42-in. diam. and 18 in. manholes, Sec. A, joint outfall sewer proj. of Santa Ana, Anaheim, Fullerton and Orange cities, at $138,852.

Colo., Denver—Dennis Gibbons & Son, 1059 Downing St., awarded contract for 36,040 ft. 8-10 in. vit. pipe and 132 manholes in Berkeley Special San. Sewer Dist., at $35,417.

Ia., Cascade—W. B. Carter, 606 United Bank Bldg., Sioux City, awarded contract for 32,000 ft. sewers and disp. plant, at $46,543 and $24,046, respectively.

Mich., Detroit—J. A. Mercier, 216 Hammond Bldg., awarded contract for Southern Avenue arm of Lonyo Rd. sewer, and Lawton Ave. arm of Morrell St. sewer, at $33,723 and $34,941, respectively.

Mich., Detroit—T. W. Blanck & Co., 823 Ford Bldg., lateral sewer 3,686, $7,370, lat. 3,738, $5,302; lat. 2,741, $2,500; lat. 3,743, $3,135; lat. 3,744, $5,570; lat. 3,747, $3,654; lat. 3,751, $4,354; A. Rossi, 5307 Penn. Ave., lat. 3,739, $2,760; lat. 3,748, $600; J. Monti, 148 St. Joseph St., lat. 3,742, $7,125; G. Ponterelli, Wolverine Hotel, lat. 3,745, $7,953; Western Constr. Co., 1208 Ford Bldg., lat. 3,746 $932· Coolsaet Bros., 400 Penobscot Bldg., lat. 3,752, $9,800.

Mich., Springwells—Contract for Sec. 16, Barclay Ave. sewer to R. A. Mercier, 5435 Wesson Ave., Detroit, at $145,000; Sec. 17, Maple Rd. sewer, Sec. 18, Dix Ave. Sewer, and Sec. 19, Eagle and Ford Ave. sewers, to Liberty Constr. Co., 1026 Book Bldg., Detroit, at $8,359, $19,637 and $9,956, respectively.

Minn., Waseca—Disp. contract let to Ward & Weighton, 510 Davidson Bldg., Sioux City, Ia., at $19,720; out. sewer, Robertson & Patterson, Springfield, Mo., at $68,438; storm sewer, Rafdal & Curtis, Medford, Minn., at $11,777.

Mo., Maplewood—A. Lewald, 5909 Ethel Ave., St. Louis, awarded contract for 28,318 ft. 8-36 in. vit. clay and 1,800 ft. 42-in. segmental blk. sewers, etc., at $169,689.

Mo., Odessa—Merkle Machinery So., 1735 Walnut St., Kans. City, Kans., awarded contract for 35,000 ft. 8-in. sewer plant, at $45,000.

N. Y., Buffalo—Contract for 27-in. tile sewer in Hewitt Ave. to Dark & Co., 654 Main St., at $8,783; 10-15 in. tile sewer in E. Hertel Ave., and 10-24 in. tile sewer in Lenox Ave., to J. M. Fahning, 460 Leroy Ave., at $4,283 and $2,418, respectively; 10-20 in. tile sewer in Parkridge Ave. and 10-15 in. tile sewer in Cornwall Ave., to L. Di Pasquale, Buffalo, at $5,315 and $5,803, respectively.

N. Y., Syracuse—Roberts Filter Mfg. Co., 6th and Columbia Sts., Darby, Pa., (slip ring) awarded contract for machy. and equipt. for sewage pumpg. sta. and grit chamber, at $76,100.

N. C., High Point—H. D. Perry, Bessemer, awarded contr. for laying 35,000 ft. sewer lines and 20,000 ft. water mains, at $34,000.

Ohio, Cleveland—Contract for 740 ft. 5 ft. and 700 ft. 4 ft. circ. brk. and 380 ft. 12-24 in. vit. tile sewer in Bessemer Ave., let to P. W. Graham, 1274 W. 108th St., at $46,679; 275 ft. 24-in. vit. tile sewer in Lake Shore Blvd., to Kassouff & Co., 3182 W. 25th St., at $4,168.

Ohio, Cleveland—Ohio Contg. Co., Elyria, awarded contract for sewers in Short, Crossview and Chestnut Rds., at $95,913; Brookpark Rd. to Enterprise Paving & Constr. Co., 8444 Broadway, at $58,-441.

Ohio, Hamilton—Central Foundation Co., 14 Wellington St., Toronto, awarded contract for storm sewer up to 36 in. in Kenilworth Ave., at $84,994.

Okla., Oklahoma City—James & Eads, Miami, awarded contract for Maywood storm sewers and san. main sewers, at $63,693.

Tex., Laredo—James Constr. Co., San Antonio, awarded contract for 15,666 ft. 12-24 in. stand. vit. pipe sewers and 33 manholes in 7th Ave., at $638,-430.

Tex., Lubbock—James Constr. Co., Southwestern Life Bldg., Dallas, awarded contract for 1,500,000 gal. (daily) Imhoff sprinkling filter disposal plant, 20 miles 6-10 in. vit. sewer and 10 mi. 6-8 in. cast iron water main, at $230,000.

Utah, Salt Lake City—J. O'Conner, Utah Savings Bldg., awarded contr. for 29,000 ft. 8-18 in. vit. sewers, at $84,340.

Utah, Salt Lake City—Griffith & Burnside, Kearns Bldg., awarded contract for sewers in Farmers Ward; 30,000 ft. 8-36 in. sanitary sewers, 18 flush tanks, at $126,674.

Wis., Ellsworth—Camden Constr. Co., care J. B. Camden, Benson, Minn., awarded contract for san. sewers in various sts., including 25,900 lin. ft. 8-12 in. pipe, at $30,732; 3 Imhoff tanks, etc., to W. L. Oltman and F. H. Johnson, Ellsworth, at $16,942.

Wis., St. Croix Falls—Bradley & Gerischer, St. Cloud, awarded contr. for san. and storm sewers, at $34,864.

WATER SUPPLY AND PURIFICATION

Ark., Conway—F. L. Scully, Conway, awarded contract for constr. of settling basin having an approx. capy. of one million gals. and 2 large filters. Contract price $1.35 per c. y. for rein. concrete.

Cal., Knights Landing—(Grafton, P. O.)—L. F. Youdall, Commercial Savings Bank Bldg., Stockton, awarded contract by Meek Est., for rein. conc. pumping plant, using Byron Jackson pumps and G. E. motors, in Recl. Dist. 730, at $22,429.

Colo., Glenwood Sprgs.—White & Johnson, Chamber of Com. Bldg., Denver, awarded contract for 4,100 ft. tunnel and 1,500 ft. conc. and metal flume and appurts. thereto for city water supply, at $70,000

Ga., Atlanta—Burford, Hall & Smith, awarded contract by City Water Board for equipment at water works consisting of two 30,000,000 gal. pumps for river sta. at $67,500 each, and one 30,000,000 gal. pump at Hemphill Sta., at $37,250.

Iowa, Bedford—Cowan & Smith, 1733 Walnut St., Kans. City, Mo., awarded contract for 19,046 lin. ft. 4-in. Cl. B cast iron mains, 3.3 tons Cl. D spcls., 28 fire hydrants, etc.; labor to N. E. Stucker & Son, Lawrence, Kans.; total cost, $18,500.

Mich., Bay City—Bay City Stone Co., Bay City, awarded contract for superstruct. for filtration plant, at $167,000.

Mich., Negaunee—Henry Trevarrow, Negaunee, awarded contract for infiltration gallery, receiving well, suction line, appurts., etc., at $17,500.

Mo., Hamilton—C. H. Everett, Hutchinson, Kans., awarded contr. for completing new water works system, at $68,488.

Mo., Milan—J. J. Hoffman, Milan, awarded contract for purification plant and extension of mains, at $13,401 and $29,000, respectively.

Ohio, Cleveland—P. F. Connolly, Commonwealth Bldg., awarded contr. for 10,400 lin. ft. 60-in. steel pipe for Fairmount Water Proj., at $398,341.

Ohio, Parma Heights—D. Pfahl & Co., Guardian Bldg., Cleveland, award. contract for 22,622 ft. 12-in. mains, at $109,852.

Ohio, Wickliffe—D. H. Whittaker, 343 The Arcade, Cleveland, award. contract for mains in Worden Ave., at $16,713; J. B. Lynn, 343 The Arcade, Cleveland, contract for mains in Wade Ave., at $3,536. Work involves 7,300 ft. 4-8 in. cast iron pipe.

Okla., Tulsa—Tibbetts & Pleasant, Inc., awarded contract to construct Elm Park relief storm sewer, at $600,000.

N. Y., Elmsford—T. M. Hughes & Co., No. Tarrytown, awarded contr. for extending mains, at $56,-304.

N. Y., New York—Beaver Eng. & Contg. Co., 57 Chambers St., awarded contract for mains on subway bridge over Bronx River and on hwy. brdg. over N. Y., New Haven & Hartford R. R.; also on Westchester Ave. and Edgewater Rd., at $10,080.

Ohio, Cleveland Heights—(Warrensville, P. O.)—B. H. Whittaker, 335 The Arcade, Cleveland, awarded contract for water mains in Blanch, So. Compton and Hyde Park Rds., at $17,262.

Ore., Medford—Lindstrom & Ferguson, Portland, awarded contract for bldg. new City reservoir of

Tex., Dallas—Chicago Bridge & Iron Wks., Prac-2 million gals. capy., at $27,561.
torian Bldg., awarded contract for one million gal. reservoir, Sunset Heights, steel tank, conc. found., at $22,700, plus $2,690 for foundation.

Tex., Marlin—National Cast Iron & Foundry Co., Birmingham, Ala., awarded contract for 562 tons pipe to lay line from new standpipe to reservoir now under constr., at $28,662.

Tex., San Juan—Gulf Machinery Co., Galveston, Tex., awarded contract at $20,780 for water works plant, for constr. of 6-in. water main and tank with capy. of 60,000 gals.

Tex., Sherman—Texas Tong & Tool Co., Elmhouse, Tex., awarded contract for second well at Fairview pumpg. station, at $20,000.

Wash., Centralia—American Wood & Pipe Co. awarded contract by Bucoda City Council for constr. of town's new water system. Work will begin immediately. Plans call for two 60,000 gal. reservoirs. Est. cost about $25,000.

Wash., Tacoma—R. C. Polk (representative of American Cast Iron Pipe Co., of Birmingham, Ala.) Tacoma, for furnishing cast iron pipe to be used in constr. of the So. J and K streets trunk water main, at $46,119.

Prospective Work

ROADS AND STREETS

Ark., Fort Smith—City Comn. plans repaving 60,000 sq. yds. sts. Est. cost $125,000. Will soon consider bids. Contemplate bldg. road from Ft. Smith to Fayetteville on day labor basis without contract. Sebastian Co. will soon let contract for 18 miles shale rd. from Ft. Smith to Greenwood.

Govt. aid project. Est. cost from $70,000 to $80,000.

Cal., Coronada—City Manager Hyatt reports plans under way for paving streets in section of City known as the flats, comprising parts of 5th and 6th Sts., Margarita Ave., Miguel and other avenues. Est. cost $150,000.

Cal., Sacramento—Bids for constr. of coast blvd. betw. Huntington Beach and Newport, will be advertised about latter part of December. N. D. Darlington, St. Hwy. Commr. Co. Engr. J. L. McBride, Santa Ana, now securing rights-of-way, which will be 100 ft. to provide for future widening.

Cal., San Francisco—City and San Francisco County plan street impvt. costing $284,000. M. M. O'Shaughnessy, City Engr.

Cal., Santa Ana—Movement on foot to widen Whittier Blvd., Pasadena Ave., as far south as possible. Conc. roadway with curbs and walks, and possibly lights would be constructed. Petition with more than 50 per cent of prop. owners signed, presented to Co. Supvrs.

Fla., De Land—Volusia County Commrs., New Smyrna Special Rd. and Bridge Dist., plans impvt. of following: Sec. of Dixie Hwy. from Rose Bay to south county line; Rd. from Dixie Hwy. to Co. line toward Shiloh, Brevard Co.; from New Smyrna to St. John's River Ferry; road from Samsula toward De Land. Contemplates voting on $600,000 bonds.

Fla., Inverness—Citrus County having plans prepared for 75 miles of paved roads. Election will be called in near future to vote on plan. E. V. Camp & Associates, Moreland & De Kalb Aves., Atlanta, Ga., Engrs.

Fla., Pasadena—Gulf Beach Resort Co., A. B. Archibald, Pres., interested in bldg. causeway from foot of Centre Ave., across Boca Ceiga Bay to Treasure Island, connecting with present brick road to Pass-a-Grille; petition Co. Commrs. to issue $200,000 bonds.

Fla., Stark—Bradford County plans following: 12 miles Sanderson Rd., Stark to Redding brdg., $48,000; 7 mi. Lawtry-Raiford rd., $28,000; 7 mi. rd. from Brooker to Wynn Farm, via Graham, $28,000.

Fla., Tampa—Hillsborough Co. Commrs. will construct approx. 100 miles hard surf. rd. in connection with 2½ mi. sea wall and fill. Contemplate bond issue.

Fla., W. Palm Beach—City Commission—Karl Riddle, City Mgr.—plans expending $122,000 for street impvts. in Paving Dist. 3; penetration method or surf. treatment. Will soon invite bids.

Idaho, Boise—State Hwy. Commission making plans for grading and gravel surfacing 10.7 miles Idaho-Pacific Hwy. F. A. P. 65, from Georgetown to Caribou Co. line, 20 ft. Est. cost $95,000. D. P. Olson, Director of Highways.

Ill., Edwardsville—Madison Co. Rd. & Bridge Comn. will take bids aiout January 1st for paving 4,135.9 ft. Sec. 41-15d, 18 ft. roadway, 6 ft. earth shoulders, 8,300 sq. yds. Portland cement conc., $23,253 to $25,000. W. E. Howden, Edwardsville, Supt. of Hwys.

Iowa, Clinton—Resolution passed by Council for street impvts.; have authorized $109,866 bonds. F. W. Needham, City Clk.

Iowa, Wapello—Plans being made for conc. pavement—30 blks. Est. cost $200,000. A. E. Archer & Co., 312 New England Bldg., Kans. City, Mo., Engrs.

Ky., Bardwell—Carlisle County plans road impvts.; considering voting on $250,000 bonds.

Ky., Hopkinsville—State Hwy. Dept., Frankfort, has approved plans for bldg. 9 miles Gracel Rd.—Hopkinsville to Gracey—connecting with F. A. Rd. crossing Trigner Co. to Eggner's Ferry on Tenn. River. Est. cost $211,000. Christian County will pay $52,800.

La., Springville—Livingston Parish Police Jury plan shard surfacing 60 miles dirt road in Dist. 3—Springfield to Ponchatoula via Springville, Ft. Vinvent, French Settlement, Maurepas and Clio. $80,000 bonds voted.

La., Vermilion Parish—Vermilion Parish has just voted $2,500,000 for road bldg.—a $500,000 tax and bond issue to link up its capitol, Abbeville, with nelghboring parish seats of Iberia, Lafayette and Acadia, besides providing for considerable mileag for lat. rds. in road dist. Dist. is composed of 5 different wards in parish represented at elect., giving a majority of 500 in number of votes and over $2,500,000 in value of assessment in favor of the tax.

Md., Baltimore—Dept. Pub. Impvts. plans bldg. 1 mile 120-ft. boulevard, connecting Govans with 33rd St. Blvd. east of Venable Stadium.

Md., Towson—Baltimore County contemplates improving roads. $2,000,000 bonds voted.

Mich., Kalamazoo—Kalamazoo Co Bd. of Supervisors voted to raise $99,912 for county roads and $146,335 for Covert Act Rds. Rds. recommended for constr. include following: 1½ mi. Oshtemo Twp., $12,000; 3 mi. on twn. line rd. bet. Schoolcraft & Brady Twps., $24,000; 1½ mi. Pavilion Twp., Pickeral Lake cors. west, $12,000; 1 mi. Alamo Twp., $8,000; 7 mi. trunk line rd. on S. Westedge Ave., Kalamazoo & Portage Twps., 1 mi. Alamo Twp., 1 mi. Schoolcraft Twp., 1 mi. Pavilion Twp., besides mile and a half recommended, 2 mi. Comstock Twp. and 1½ mi. Cooper Twp.

Mich., Lansing—State Hwy. Commr. F. F. Rogers has prepared tentative program for constr. of approx. 933 miles in 1923, to be divided as follows: 282.31 mi. pavement; 80.85 mi. macadam; 449.05 mi. gravel and 120.6 mi. grading and culvert work. Est. total cost $14,522,300.

Minn., Duluth—Paving program for 1923 includes: 2300 ft. Mich. St.—Lake to 5th Aves., W.; 1840 Fifth Ave., Superior St. to dock front; also 6 streets in Lakeside residential dist. Conc. or macadam. E. K. Coe, City Engr., 1114 E. Third St., Duluth. J. A. Farrell, Commr. Est. cost $1,000,000.

Miss., Charleston—Tallahatchie Co. plans bldg. 18 miles surf. hwy. between Charleston and Webb, connecting Charleston and Sumner; Delta Hwy. with Air Line Route of Jefferson Davis Hwy. $200,000 bonds voted.

Miss., Vicksburg—Mayor plans expending $130,000 for 40,000 sq. yds. street paving. J. J. Hayes, Mayor; F. M. Garvey, City Engr.

Neb., Omaha—Will probably call for bids in near future for resurfacing 24 paved streets. Est. cost $250,000. C. F. Bossie, City Clk.

N. J., Newark—$400,000 bonds voted by Essex County for parkway to connect Branch Brook Park with Bellvills Park.

N. Y., Rochester—City considering laying sidewalks and grading Meadowbrook Rd., Arbor Dr., Laney and Azalea Sts., $38,800; paving Santiago St. conc., $11,900; Lapham St., asph., $22,300; Marlboro Rd., asph., $11,800; Salina St., asph. blk., $12,200. C. A. Poole, City Engr.

N. C., Snow Hill—Town contemplates hard surfacing principal business and residential streets.

Ohio, Bedford—Suburban Land & Homes Co., care H. H. Hardesty, 1011 Swetland Bldg., Cleveland, having surveys made for grading, laying walks, mains and sewers at Stop 17, Bedford. $100,000. F. A. Pease Eng. Co., Marshall Bldg., Cleveland, Engrs.

Okla., Oklahoma City—State Hwy. Commission will soon let contract for hard surfacing about 100 miles Postal Hwy. bet. McAlester and Fort Smith; gravel, bitum. or conc. Approx. cost $2,500,000, half to be paid by state and half by Fed. Aid fund. B. E. Clark, State Commissioner of Hwys.

Ore., Astoria—$50,000 appropriated at recent meeting of taxpayers for purpose of paving main Nehalem Hwy. from end of present pavement at the Olney cutoff; Astoria Rd. Dist. appropriated $20,000 in addn. to the $18,000 already in fund, to pay for Williamsport rd. leading along short of Young's River from ft. of 7th St. in this city to connect with Nehalem Rd.

Ore., Portland—City Engr. Laurgaard will report to City Council on proposed widening of Sandy Blvd., in connection with widening of E. Burnside and E. Couch. Combination project, estimated to cost about $390,000.

Tex., Austin—State Hwy. Dept. Austin, has approved following plans: Surf. 11.55 miles State Hwy. 3, Medina Co., gravel and bitum. topping, $180,000; 10.75 mi. St. Hwy. 3, Medina Co., gravel bitum. rd., $158,000. R. J. Noonan, Co. Judge; Walton & Ameson, Co. Engrs., Gunter Bldg., San Antonio, Tex.

Tex., Beaumont—U. S. Bureau Pub. Rds., Washington, D. C., has approved plans for 17 miles 18-ft. conc. paved road on State Hwy. 3, Amelia to Liberty Co. line; Jefferson Co., F. A. P. 312, $558,604. J. B. Peak, Co. Judge. A. C. Love, Co. Engr.

Tex., Dallas—Plans being made for widening, paving and extending St. Paul St.—Commerce to

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Air Lift Pumps.
Harris Air Pump Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitoslag Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitoslag Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The.
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling & Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Trailer and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co.

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling & Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling & Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Leeter.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Central Heating Plants.
American District Steam Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L., The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Condnits.
Cannelton Sewer Pipe Co.
Carey Co., Philip, The.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossman, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill, Nicholas S., Jr.,
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Leeter.
Luten, Daniel B.
Morse, Wm. F.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L., The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Road Machinery Co.

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling & Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Austin-Western Road Machinery Co.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

Marilla Sts.—50 ft., $308,000. G. Fairtrace, City Engr. E. A. Ward, City Plan Engr. Dallas County having plans prepared and will take bids about Dec., for improving 12.6 mi. Richardson Rd., St. Hwy. 6, 18-20 ft., $600,000; take bids about January for grading and bitum. surfacing 6 miles Bonnie View Rd., 18 ft., $75,000; 13 miles Beckley Rd., 18 ft., $150,000; 4 mi. W. Dallas-W. Moreland Rd., 18 ft., $60,000. Nagle-Witt-Rollins, Court House, Engrs.

S. C., Winnsboro—Fairfield Co. will construct road connecting Cheer and Richland Cos.; $500,000 bonds voted.

Tex., Houston—Harris County contemplates voting on $890,000 bond issue for grading and conc. surfacing 17.8 mi. La Porte Rd.—Galveston Pike to La Porte, 18 ft. including bridges over Simms and Vina Bayou; $540,000 bond issue for 12 miles of road betw. Ureka and Cypress, 18 ft. Howe & Wise, 211 1st Nat'l Bank Bldg., Engrs. Harris County plans constr. of 12 miles 18 ft. conc. road on Washington Co. road betw. Eureka and Cypress. Est. cost $540,000. Howe & Wise, Engrs., 211 First National Bank Bldg.

Tex., Houston—Mayor plans expendt. of $1,600,000 for paving, including 2 new highways in Houston Heights from North Side and South End; Polk Ave. from business dist. thru Eastwood toward Harrisburg; Dumble St. connecting McKinney Ave. with Harrisburg Blvd.; Washington Ave., business district to Heights; Preston Ave. to Dowling St.; Dowling St., Preston Ave. to Holman. Plans graveling 32 streets. O. F. Holcombe, Mayor.

Tex., Jasper—Jasper County plans 11 miles 16-ft. gravel rd. on State Hwy. 8, Buna to Hardin Co. line, $163,000. C. B. Neel, Co. Judge; C. P. Hunter, Co. Engr.

Tex., Liberty—Liberty County, S. H. Caln, Judge, will build 36 miles of 18-ft. conc. paved rd. on St. Hwy. 36, Houston-Beaumont Rd. from Harris Co. line to Jefferson Co. line; State and Fed. Aid, including county bond issue. Total $300,000. W. C. Young, County Engr.

Tex., Paris—Lamar Co., W. L. Hutchinson, Co. Judge, plans following impvts.: Surf. 9.9 mi. St. Hwy. 19, no. of Paris, gravel, $63,500; surf. 9.24 mi. St. Hwy. 19, so. of Paris, sledged limestone rock base; gravel top, $75,200. W. M. Fooshee, Co. Engr.

Tex., Pittsburg—Chief Engr. U. S. Bureau Pub. Rds., Washington, D. C., approved plans for 16.66 miles 16-ft. gravel bitum. rd. on State Hwy. 1-A, Camp Co., F. A. P. 55. Est. cost $308,720. J. A. Elfried, Co. Judge. Chas. C. Chappell, Co. Engr. Bureau also approved plans for 10.43 mi. 16-ft. gravel bitum. rd. on State Hwy. 19, from Harris Co. line to Brazoria Co. line, Ft. Bend Co., F. A. P. 318. Est. cost $150,000. C. D. Myers, Co. Judge (Richmond), and C. H. Kendall, Co. Eng. (Richmond). Plans also approved for 3.75 miles State Hwy. 17-A, Reeves Co., F. A. P. 320, $22,865. J. F. Ross, Co. Judge, Pecos; A. D. Adcock, Co. Engr., Balmorhea, Tex.

Tex., San Antonio—Ch. Engr. U. S. Bureau Pub. Rds., Washington, D. C., has approved plans to surf. 8.38 miles St. Hwy. 2, macadam, Bexar Co., F. A. P. 264, $145,027. A. McCloskey, Co. Judge; R. E. Keoler, Co. Hwy. Engr. Bureau has also approved plans for impvt. of 7 mi. Chandler Rd., Smith Co., F. A. P. 316, $80,000. D. R. Pendleton, Co. Judge. D. K. Caldwell, Co. Engr.

Tex., Sequin—Chf. Engr. U. S. Bureau of Pub. Rds., Washington, D. C., has approved plans for 3.4 miles 15-ft. gravel bitum. road on St. Hwy. 3, $36,744. Hess & Skinner, Engrs., Southwestern Life Bldg., Dallas, Tex.

Tex., Sinton—San Patricio County will soon ask bids for surfacing 16.1 mi. San Antonio-Corpus Christi Rd., east branch of St. Hwy. 9, with 1-in. bitum. topping. Approx. cost $105,000. A. C. Pancoast, Co. Engr., Beeville, Texas.

Va., Petersburg—City plans expendt. of $150,000 to repave Sycamore St., Grove Ave. to Wythe St., and W. Washington St., Sycamore to city limits. L. Browlow, City Manager.

Wash., Seattle—Second Denny Hill regrade proj., involving removal of 3,600,000 c. y. earth west of Westlake Ave., bet. Virginia and Denny way, is under consideration. City Engr. J. E. Blackwell requested to prepare surveys and cost ests. of work. Should the work contemplated prove as costly as the pending Beacon Hill sluicing proj., the cost will be three to four million dollars.

Wisconsin—Taylor County Bd. appropriated $9,000 for rd. mchy. C. Keinhofer, Medford, Commr.; Co. Co. Bd., $212,174 for st. & co. aid rd. & brdg. constr. Henry Mink, Lancaster, Commr.; also $12,000 for rd. mchy, including 1 tractor, 2 trks, 1 12-in. blade grader, 10 patrol graders and 10 rd. drags; also $500 for mach. shop equip.; Jackson Co. Bd. $3,000 for rd. mchy., including 1 tractor, 12-in. grader and 2 patrol graders. Wm. Tibbits, Black River Falls, Commr. Oconto Co. Bd. made available for st. and co. aid rd. and brdg. constr. $61,000. E. W. McAllister, Oconto, Commr. Also appropriated $5 000 for rd. mchy. Milwaukee Co. Bd. approp. $509,848 for state and co. aid rd. and brdg. constr., also $10,000 for rd. mchy. W. F. Cavanaugh, Milwaukee, Commr. Pepin Co. Bd. appropriated $40,669 for state and county aid rd. and bridge constr.; also $3,500 for rd. machinery, including 10-ton tractor and large grader. Gale A. Goss, Durand, Commr. Fond du Lac Bd., $10,000 for various kinds of rd. mchy. Geo. Treleven, Fond du Lac, Commr. Jackson Co. Bd. made available for state and county aid rd. and brdg. constr., sum of $105,757. Wm. Tibbitts, Black River Falls, Commr. Marathon Co. appropriated $158,062 for state and co. road and bridge constr. in 1923; also $14,000 for purchase of rd. mchy., including one 12-in. and 6 patrol graders, one gravel crushed and screening plant. J. H. Vogt, Wausau, Commr. Clark County will have available for state and county aid road and bridge constr., $99,817 in 1923. Bd. has also appropriated $6,000 for purchase of road machinery, including graders. O. J. Wehmiller, Commr.

W. Va., Charleston—State Road Commission has tentative plans for following projects in Clarksburg Dist.: 9 miles from Cycamoredale to Jane Lew, connecting Clarksburg and Weston; Rd. from Bridgeport to end of paving west of Grafton, connecting Clarksburg and Taylor Co. seat; build gap bet. W. Union and Harrison Co. line; awards contingent upon passing of $15,000,000 or $20,000,000 bond issue.

W. Va., Weston—City will extend paving system and install sewerage system. Vote in December on $300,000 bonds. Half for paving and half for sewerage.

W. Va., Weston—Lewis Co. Commrs. Court, Freeman's Creek Dist., will construct 25 miles hard surf. roads as follows: Jackson's Hill to Freemansburg; Camden to Fink; Weston to Kincheloe brdg.; Alum brdg. to Fink; $800,000 bonds voted.

SEWERAGE AND SEWAGE TREATMENT

Cal., Lodi—City plans election to vote on issuance of $100,000 bonds for sewage disposal plant. C. F. Smith, 7 Nottingham St., Berkeley, Cal., Engr.

Cal., Pomona—City Engr. F. C. Froehde & Mayor T. R. Oveington have proposed a $100,000 bond issue to provide funds for constr. of new outfall sewer. Present sewer line is inadequate, one entire section of city being without sewerage. It is proposed to build a joint line with old one, suitable for city of 40,000. Sys. approved by St. Bd. of Health, provides for activated sludge plant on 100 acre farm owned by city.

Cal., Tracy—Election will be held to vote on $50,000 bonds for sewage disposal plant, Imhoff tank, etc. W. D. Harrington, City Engr.

Ont., Hamilton—Plans being prepared for intercepting sewerage system. E. R. Gray, City Engr. Est. cost $25,000.

Qubec, Hull—Council will construct sewers at cost of $100,500 and water works extensions at cost of $59,000. Work by Day Labor, Theo. Lanctot, Engr.

Ont., Ottawa—City will construct storm sewer at cost of $50,.000 on Harmer St. by Day Labor. A. F. Macallum, Commr. of Works.

Ont., Sandwich—Plans being prepared for sewage disposal plant. Est. cost $160,000. Prices desired on all materials. McCall & Patterson, Gas Bldg., Windsor, Cons. Engrs.

Colo., Denver—Plans and estimates being prepared for storm sewer in Park Hill storm sewer dist., $1,000,000. A. K. Vickery, City Hall, Engr.

Conn., Hartford—City planting exten. of interceptor sewerage sys. Est. cost $34,000. City Engrg. Dept., care Pub. Wks. Bd. Engrs.

Fla., Jacksonville—City will lay storm water pipes to drain abt. 40 acres in vicinity of 26th and Perry Sts. Est. cost $19,000; relay san. sewers on

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E. Mfg. Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling & Harnischfeger.
Sauerman Bros.
Smith Co., T. L., The

Expansion Joint Compound.
The Barrett Co.
Carey Co., Philip, The
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machin-
Good Roads Machinery Co., Inc.
ery Co.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Plants, Central.
American District Steam Co.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling & Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Incinerators.
William F. Morse.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
Carey Co., Philip, The.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machinery Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
The Barrett Co.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Co.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Fluehers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co.
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L., The
Warren Bros. Co.

Pipe Cutters.
W. W. Stickler & Bros.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Mach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Myrtle Ave., bet. Enterprise and State St., $14,000; establish sewer outfall near end of Clay St., $6,655. W. E. Sheddan, City Engr.

Fla., St. Petersburg—City plans constr. of san. sewerage system, $90,000; replacing sewers, $40,000. C. C. Brown, Acting Director of Pub. Wks.

Ia., Muscatine—Plans made for draining so. part of city. Center State Engrg. Co. C. H. Young, Muscatine, $98,880.

Ia., New Vienna—Plans completed for sewer system and disposal plant. Will ask bids early in 1923. Howard R. Green Co., Cons. Engrs., Cedar Rapids.

Ia., North English—Town will advertise for bids in January for complete sewer system and disposal plant. H. R. Green Co., Cons. Engrs., Cedar Rapids.

Ia., Ossian—Howard R. Green Co., Cons. Engrs., Cedar Rapids, Ia., preparing plans and specfs. for complete sewer system with disposal plants. Bids will be asked late in January.

Ia., Washington—City will probably start work in February on trunk sewer and disposal plant. Cons. Engrs. W. E. Buell & Co., 205 Grain Exch. Bldg., Sious City, Engrs. Est. cost $200,000.

Kans., Oakley—Plans being prepared for new sewerage system and disposal plant, $50,000. C. A. Haskins, 517 Finance Bldg., Kansas City, Mo., Engrs.

Mass., Fall River—City plans constr. of sewerage extension on N. Main St., no. of New St., $100,000. A. Wolstenholme, City Engrs.

Mich., Ferndale—City plans laying 10,000 ft. lateral sewers in Rockwell Ave. and other streets, including 3,000 ft. 10-in., 3,000 ft. 12-in. and 4,000 ft. 15-in. vit. or conc, pipe. Est. cost $40,000. G. Jerome, 1331 Majestic Bldg., Detroit, Engr.

Minn., Henning—Plans made for sewer system. Druar & Millnowski, 500 Globe Bldg., St. Paul, Cons. Engrs. Maturity indef. O. L. Scorheim, Vil. Clk. Est. cost about $60,000.

Minn., Rochester—Constr. of sewage disposal plant being considered. Est. cost $150,000. Jas. T. Spillane, Sewer Commr.

N. J., Elizabeth—Plans being made for sewer under Elizabeth River, at 3rd Ave., betw. Palmer and Garden Sts., $60,000. J. H. Fuertes, 140 Nassau St., New York City, Engr.

N. J., Roselle—City preparing plans for 12-24 in. tile and conc, sewers in vicinity of Pine St. and 9th Ave., $40,000. J. L. Bauer, 120 Broad St., Elizabeth, Engr.

N. J., South River—City plans 3,800 ft. trunk sewere in Hillside Ave. Est. cost $28,000. C. C. Armstrong, Soith River, Engr.

N. M., Santa Fe—Plans being completed for sewage plant. Est. cost $115,000. H. F. Gray, Santa Fe, Engr.

N. Y., Rochester—City plans constr. of sewage disposal plant in Hopper Hollow Sec., $50,000; sewers and walks in Crossman Terrace, $31,300. C. A. Poole, City Engr.

N. C., Saluda—Additional sewer constr. contemplated by city, $250,000 bonds.

Okla., Shattuck—Plans prepared for sewer laterals, $45,000. H. G. Olmsted & Co., 415 Oil Exchange Bldg., Okla. Ctly, Engrs.

Pa., Ambridge—City plans sewage disposal plant on Ohio River, cost to exceed $25,000.

Pa., Butler—City Counlil authorized $300,000 bond issue for sewage disposal plant.

Pa., Harrisburg—$150,000 bonds voted for sewers. M. B. Cowden, City Engr.

Pa., Midland—City plans 1,860 ft. 48 in. san. sewer extension at cost of $40,000. J. P. Stone, Boro. Secy. Engineer not announced.

S. C., Clover—City will install sewerage system and water works; $65,000 bonds voted.

S. D., Watertown—Resolution passed for constructing sanitary sewer on various streets. B. Mather, City Aud.

S. D., Yankton—City will construct san. sewer in Spring; 10, 12, 15 and 18-inch pipe. Est. cost to state $18,000, to city $19,000. John W. Summers, City Clerk.

Tex., Harlingen—City has plans for sewer system. Will soon call for bids. Est. cost of disposal plant, $20,000; cost of sewer system, $52,000.

Tex., Tulia—$30,000 bonds voted here for sewer extension.

Wash., Hoquiam—Estimates being compiled by Chief Engr. W. L. Lovejoy for 3 sewerage districts. Ests. are for replacement of wood box sewers which have been in use for several years. Districts are as follows: All of city no. of Emerson St. and west of Lincoln; all east of Lincoln and no. of Eklund Ave.; all of city west of Ontario St. In last named district, west of 28th St., there are no sewers.

Wis., Marshfield—Plans being prepared for san. and storm sewers, including septic tank, $25,000. G. Leonard, Clerk. T. Pankow, Wash. Bldg., Madison, Engr.

WATER SUPPLY AND PURIFICATION.

Ala., Mobile—City contemplates extending water works system and improving fire department. Will vote on $400,000 bond issue.

Ont., Kingston—City considering bldg. filtr. plant. Est. cost $350,000. Howard Dick, Engr.

Ont., Hanover—$135,000 bonds voted for extension to water works system, including reservoir, 3 miles pipe line to Rhul Lake, etc. F. W. Thorold, 54 Admiral Rd., Toronto, Engr.

Ga., Atlanta—City will extend water pipe line on various sts. at cost of $150,000. Walter C. Taylor, Clerk.

Ga., Waynesboro—City will install water works and sewer system at cost of $100,000. J. B. McCrary, Engr., Atlanta.

Md., Williamsport—City will install water works system; $100,000 bonds voted.

Mo., St. Louis—Board of Estimates and Apportionment approved bond items, aggregating $88,372,500. City will vote Feb. 9 on bond issues for following work: Water works, hospital, sewer system, electric light, playgrounds, new paving, impvt. of present paving system, grade crossing and viaducts, municipal heat, light and mechanical bldg., fire department equipment, civic bldg., city market, memorial plaza, sites for memorial and civic bldgs., etc. W. Frank Carter, Chrmn. on Civic Needs.

Mo., St. Louis—City contemplates purchase of coated cast iron pipe, special castings, valves, fire hydrants, valve boxes and other materials, $100,000. E. E. Wall, City Hall, Water Commr.

N. Y., Keeseville—Appropriation of $100,000 voted for village water supply.

N. C., Asheville—Plans of Carolina-Tennessee Power Co., which has its main offices in New York, for hydro-elec. power development on Hlawassee River in Cherokee county, nearing completion. Development will involve construction of 2 dams and 2 generating stations of sufficient capacity for producing 60,000 horsepower. Cost of proj. estimated at $5,000,000 to $7,000,000. Capital available. Preliminary surveys completed and specfs. for work nearly finished.

N. C., Elizabeth City—City will improve sewer system, water works and light system; $800,000 bonds voted. Wm. C. Olson, Kingston, Cons. Engrs.

N. C., Lincolnton—City will extend and improve water, sewer and electric light systems; $180,000 available.

N. C., Marshville—City will install water, sewer and electric systems; $140,000. J. B. McCrary Co., Engrs., Atlanta.

Okla., Woodward—Will vote on $175,000 bonds for construction of water system. City has plans; prepared by Black & Veatch, Cons. Engrs., Kansas City, Mo.

Ore., Portland—City considering construction of Bull Run pipe line, 10 miles 60-in. and 14 miles 52-in. riveted steel pipe, or 10 miles 58-in. and 14 miles 50-in. lock bar pipe, clearg. and grubbg. 16 acres three 80-ft. comb. hwy. and pipe spans with abutments, $1,000,000. F. Randlett, Chief Engr.

Ore., The Dalles—Prelim. studies and estimates being made preliminary to bond election for earth dam and pipe line betw. Mill Creek and east fork of Hood River. Est. cost $300,000. Stevens & Koon, Spaulding Bldg., Portland, Cons. Engrs.

S. D., Rapid City—Plans being prepared by Cons. Engrs., Burns & McDonnell, 402 Interstate Bldg., Kansas City, Mo., for water works impvts., $175,000. J. J. Hayes, City Council.

Wash., Bellingham—Election in December to vote on $1,000,000 bonds to change city's water supply from Lake Whatcom to Skookum Creek, 17 miles, from Lake Padden, the proposed reservoir.

Wash., Tacoma—City contemplates 75,000 h. p. development; reservoir to store 190,000 acre-ft. power plant, dam, transmission line, etc. Est. cost $7,768,000.

BUYERS' GUIDE

Pumps.
De Laval Steam Turbine Co.
Evinrude Motor Co.
Harris Air Pump Company.
Keystone Driller Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Keystone Driller Co.
Littleford Brothers.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Road Rollers.
Austin-Western Road Machinery Co., The
Buffalo-Springfield Roller Co.
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co.
The Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Carey Co., Philip, The.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling & Harnischfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Pipe Joint Compound
The Barrett Co.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co.

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co., The
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co., The
Littleford Bros.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co., The

Street Paving Material.
The Texas Co.

Street Sprinklers (Horse Drawn).
Austin-Western Road Machinery Co., The

Structural Steel.
Lewis-Hall Iron Works.

Subgrading Machines
Austin Machinery Corp.
The Hug Co.

Surveyors' Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Sweepers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Tamping Machines.
Pawling & Harnischfeger.

Tanks, Water Supply.
Littleford Brothers.

Tar and Pitch
The Barrett Co.

Tar Heaters.
Littleford Brothers.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Nutting Co., H. C.
Van Trump, Isaac.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
Austin Machinery Corporation.
Holt Mfg. Co., Inc.

Traffic Signals.
Electrical & Specialty Supply Co.
Little Giant Co.

Trailers.
Lee Trailer and Body Co.

Trench Braces.
Kalamazoo Fdry. & Mach. Co.

Trench Machinery.
Austin Machinery Corporation.
Kalamazoo Fdry. & Machine Co.
Pawling & Harnischfeger.

Turbines, Steam.
De Laval Steam Turbine Co.

Turntables, Truck
The Hug Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Murphysboro Paving Brick Co.
Springfield Paving Brick Co.

Wood Block (Creosoted).
Barrett Co., The
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